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August 18, 1927

Engineering News-Record

Determining Snow-Removal Requirements

Fifth article of the series on highway maintenance

Long Concrete Bowstring Bridge Erected in France

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New Texas Line of the Chicago, Rock Island & Pacific Ry.

Motor Trucks Used to Make Heavy Railway Fill in Texas

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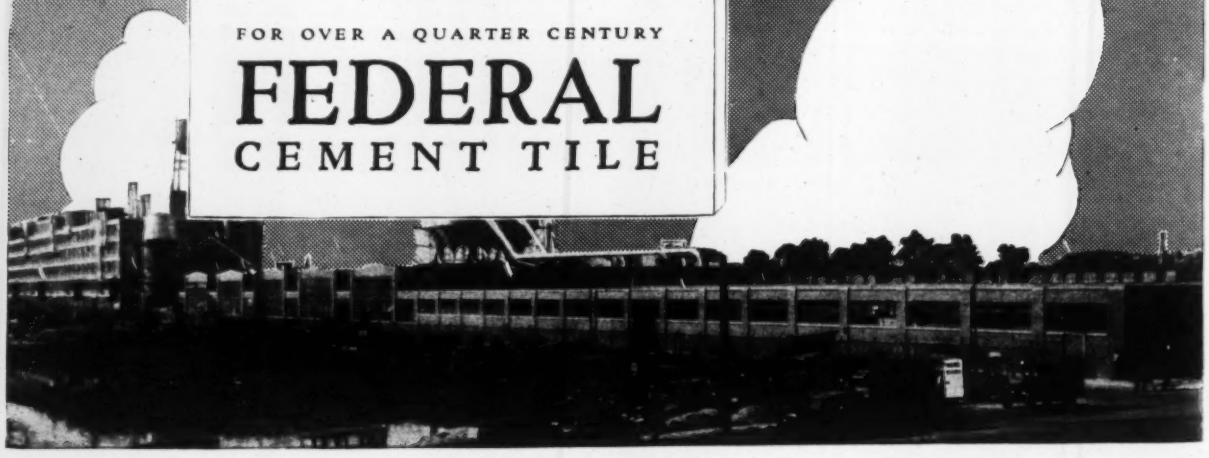


A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-President*

FRANK C. WIGHT
Editor

Volume 99 NEW YORK, AUGUST 18, 1927 Number 7

Glimpses of the Far East

GLIMPSES of Egypt, Palestine, Syria and Turkey, as caught by a past president of one of our national engineering societies, are visualized as far as words and a few carefully selected snapshots can do it in an article elsewhere in this issue. Were it not for the modesty of the author the glimpses might have been made still more graphic by reproducing some of the many pencil and water color sketches with which he enriched memories of his trip. Too few engineers among those so fortunate as to travel leisurely through foreign countries use either pen, pencil or brush—much less all three—to record what they see and fewer still share their record with others.

Mayor Thompson's Plan

CIRCUMVENTING the government of the United States is not likely to be so easy a task as Mayor Thompson assumes in his anti-meter campaign. His plan to substitute a waste survey and leak prevention campaign for the government order to install thousands of meters every year until all water consumed is metered is either bluff or shows a childlike innocence of the function of his proposed substitute of universal metering. This is not to condemn waste prevention work, which might well be vigorously pursued alongside with metering but can never take the place of the latter. As to an officer of the War Department having assured Mayor Thompson or his representative that the plan outlined elsewhere in this issue will be accepted by the government as a substitute for wholesale metering, we would prefer to see an official statement as to that rather than a second-hand version.

Book Cost and State Control

ADVOCATES of historic cost rather than reproduction cost new as a utility rate base will be pleased with the announcement that "book cost" is to be used in fixing the capitalization of the New Jersey Bell Telephone Co., a new company which is taking over the property of the New York & New Jersey Telephone Co. in the easterly and the Delaware & Atlantic Telephone Co. in the westerly part of the state. Just what "book cost" means in this case is not stated, but the New Jersey Public Utility Commission is reported as stating that reproduction cost new would have been a higher figure. Book cost, fairly established, has much in its favor, one of the main points being that it provides a more stable rate basis than reproduction cost. The latter has been strenuously fought for by utility companies generally during the last ten years of high construction cost index. The struggle raises the interesting question: How will the utilities meet the situation if and when construction costs fall? Another subject for reflection presented by the consolidation already mentioned is the deliberate choice of state rather than interstate control, which is declared to be favorable to the telephone company. This is notable at a time when so many companies are supposed to favor interstate rather than state supervision. Does the choice of both "book cost" and state control on the part of component parts of one of the greatest utility companies in the world suggest a new trend in the field of public utilities?

Road Administration Changes

LEGISLATURES have been active during the past winter in changing the organizations of state highway departments. From a count of 45 states by the Association of State Highway Officials it appears that eleven states will administrate their roadwork with a new set-up of supreme authority under the governor. In a few states the change is titular rather than functional, but broadly the new state highway directing bodies have a composition and a distribution of authority quite different from those previously existing. California, Iowa and Oklahoma enlarge their highway commissions from three men to five men; Kansas changes from a three-man to a six-man commission, and North Dakota cuts its five commissioners down to three. In respect to department chief engineer, California gives his appointment to the director of public works; Idaho dispenses with the office and puts roadwork under the commissioner of public works; Alabama combines the positions of chairman of the commission and chief engineer in a director of highways; Kansas places a director, who is to be a business man, in control of the engineering department; North Dakota retains a chief engineer but makes the secretary of the commission its chief administrative head; Nevada enlarges the duties of the state highway engineer. In Iowa the dean of engineering of Iowa State College is no longer an ex-officio commissioner, the governor appoints all the members; in Nevada the governor becomes chairman of the board and his secretary becomes secretary of the board; in North Dakota the governor becomes chairman of the commission. There is not much in this brief epitome of new highway legislation, nor is there any more in the new statutes at length, to gratify the engineer concerning the power and authority he is gaining in highway administration. The politically elected and appointed official is in the ascendency in public roads affairs.

Votes Not Expectations Count

INASMUCH as the upholding of city zoning by the U. S. Supreme Court and most of our highest state courts that have passed upon it leaves the higher courts of New Jersey still unconvinced that zoning runs counter to the Constitution of New Jersey, the voters of that state should cast their ballot for the constitutional amendment on zoning that has passed two successive state legisla-

tures and will be submitted to the people at large on Sept. 20. In no other state has zoning met with more hearty approval, both by city authorities and citizens. Witness to this is borne by the many cities and towns that have adopted zoning ordinances, the pertinacity with which the authorities have resisted attempts to break down the ordinances, and the support given the authorities by the general public. It is reasonable to expect that the amendment will be adopted but it will be votes, not expectations, that will settle the question on Sept. 20.

Snow Removal Research

TO GET at the fundamentals of snowfall as they may influence the volume and processes of snow removal from highways the state of Michigan has for three years conducted a study which bulks large in highway engineering research. It is the director of this research who writes the two articles on winter maintenance—which is largely snow removal—in the series of maintenance articles which began in *Engineering News-Record* of July 21. For the first article on snow removal requirements it is probable that the practical patrolman will have scant reverence but the research engineer will recognize in it a penetrating study of possibilities in scientific prognostication of the volume and spread of snowfall requiring removal. The patrolman will find his pabulum in the succeeding article on snow removal methods and equipment. The two articles, we believe, present the most practical information which has so far been developed concerning the main task in the winter up-keep of roads. Both articles, but more particularly the second, emphasize drift prevention as a major process in keeping winter roads clear of snow. This is in line with recent practice in states of heavy snowfall which elevates the snow fence to a position of importance alongside the snow plow in the investment for snow fighting equipment.

Intelligent Housekeeping

ACCORDING to figures supplied by the National Fire Protection Association the city of Norfolk, Va., which had, during the eight-year 1916-1923 period, a per capita fire loss of $10.38, reduced that figure to $1.79 for 1926. The per capita losses for 1924 and 1925 were $3.04 and $2.52, respectively. The reduction, we are told, was largely a matter of the association's pointing a way to better protection. Continuous inspection eliminated fire-breeding rubbish. Suspicious fires were promptly investigated by an arson squad. Salvage work was undertaken to minimize water damage. Fire prevention was taught in the schools, and the firemen themselves received regular intensive instruction. Finally, the water pressure serving high-value property was increased. The figures herein cited are too convincing to be passed without comment. Apply the per capita saving in Norfolk to several hundred American cities and an astounding potential saving is shown, a large share of which, now lost, must be considered as the cost of civic laziness. Such a record as Norfolk has made does not mean dollars alone saved. Concomitant benefits are a decline of insurance rates, greater industrial safety and improved construction methods. Norfolk can be congratulated for its exhibition of intelligent housekeeping.

A Coming Tendency

IN OUR modern existence the ephemeral nature of home building is so outstanding that it may perhaps be ranked as a characteristic feature of the age. Were an observer to come into the midst of the civilized life of today with a perspective of centuries—and yet the power to compare justly the different conditions of the several ages—he could not fail to wonder at the attitude which governs this class of building. He would notice that where past generations built their homes for grandson and great grandson, the builder of today, with infinitely greater home comfort at his command, erects a home to last half a dozen years, then to be sold or replaced by a structure of other type and service. The sentiment that in former times attached each man to his own acre no longer exists.

Back of this phenomenon lies the amazingly rapid progress of modern times, a progress of ever-increasing speed, as underlying cause. Time and permanence were valued in an age when the world was more stable, but that stability has vanished, or temporarily is concealed, and much of the value is gone. Death and taxes still remind us of the passage of time, but of these death at least has been postponed by scientific progress and perhaps some day may be put off indefinitely. Surely, time is bound to lose its former meaning in a world where men jump across continents and oceans, where at a given instant the voice of one man may be heard by millions, and where the dimensions of space have been made so diminutive that within a scant few decades a whole nation has become almost nomadic.

With these conditions surrounding us, with further momentous changes likely to be just ahead, men may well come to a far-reaching disregard of time values, of permanence. Such conditions do not favor planning for long-time stability, for building homes to be maintained a hundred years, or for planning cities and communities on the basis of permanent service. Even though the spirit might lead the individual to wish for rest and a settling down, the physical factors of life change too rapidly to permit it. The home of one decade is obsolete, no longer adequate for the needs of life, when the next decade brings its improved bath tubs and boilers, its radio equipment and its electric household servants. Nor is the city any more stable than the home, under the kaleidoscopic changes in living and business conditions.

What prospect lies ahead along this line of evolution? Rapid progress of mankind will no doubt continue, and it promises to bring with it further devalorization of time and of permanence. If such progress should go much further, however, the outlook would appear rather hopeless. Moreover, the prospect of a world devoting all its productive energies to mere rebuilding, scrapping, and renewed rebuilding seems quite unreal. There must be a point at which a balance is reached between replacement of the obsolete and preservation of that which past labor has wrought.

Granted that productivity has been so raised, by machinery and science, that a minimum of human working capacity is sufficient to supply all necessities, yet it is stupidly wasteful to devote all the surplus producing power to a thoughtless discarding of that which was laboriously built yesterday, and an equally thoughtless rebuilding in haste with the vain hope of satisfying the desires of tomorrow. Up to now, however, the trend toward the ever more ephemeral seems dominant without dispute. If there is to come about any change from this

trend, it is certain that we must soon see the beginning of an effort at headway against the modern current, and toward a revaluation of the time factor.

Some beginnings of tendencies of this kind are already observable, if we look closely. We see them in the protests against unrestrained transformation of cities, as embodied for the present in zoning movements. We see something similar in quite another field, namely that of study of engineering materials; research work of recent years has given increasing attention to matters of permanence, to the preservation of materials from rust, decay and wear, in order that both structures and machines may endure to a long life. And in still another field, conservation of resources has been made a focus of attention, a movement which was shortlived but is bound to come again into the foreground of public attention and endeavor.

The tooth of time, in short, is felt today much as it was in all past ages. Mankind is still engaged in a struggle against its ruinous effects. The struggle is everlasting, though for the time being it may be less easily recognized. Permanence, its final aim, has greater importance than in any prior era, for in spite of the shifting basis of life man's efforts and their products are of higher value, and more is at stake than ever before in saving them through consistent striving after permanence. The future will give new distinction to this old ideal.

Wanaque Confusion

CONFUSION increases with each step taken by the North Jersey District Water Supply Commission in the Wanaque aqueduct controversy. Starting with the single issue of steel vs. concrete, one new issue after another has been brought into the controversy by the special engineers engaged by the commission. The latest outside engineering report on the subject, editorially summarized on p. 274, multiplies the new and elaborates the old side issues brought forward since the controversy began. No exhaustive analysis is needed to show that the enlarged pipe lines adopted by the commission will take much more steel pipe than the original Johnson plan and that no provision has been made to ensure competition.

Among the new issues in the controversy since it was in the simple phase of steel vs. concrete are yield of a watershed and reservoir, the location, area and storage capacity of which, as Mr. Snow points out in his report, are already fixed by construction work completed and under way; the advisability of aerating the water, as provided by the abandoned plan; the relative advantages of a single and a double aqueduct; whether the carrying capacity of the aqueduct should be 150 per cent of the contract figure for yield of watershed and reservoir or but 135 per cent—jumped in the latest outside report to 180 per cent.

In the course of the controversy, both the engineers for the commission and the contracting municipalities have been treated shabbily by the commission. First the commission engaged a special consulting engineer to advise it on which material to use. Later, when this engineer advised the use of steel and the commission's engineers stood by their plans and estimates, the commission adopted the general plans of the special engineer and put the preparation of plans and specifications in his hands, avoiding a decision on the mooted question of sizes, but instructing him to make the pipe large enough to fulfill the contracts with the municipalities, although the special engineer had maintained that the safe yield of the watershed and reservoir was less than the contract requirements.

At this juncture, some of the contracting municipalities demanded copies of the controversial reports, withheld from them and the public, and requested a review of the reports by an impartial engineer, to be agreed on jointly. After assenting to an engineer-umpire and failing to obtain the services of the engineer mutually agreed on, the commission appointed a man of its own choice, against the protest of some of the contracting municipalities.

Practically coincident with the receipt of the report of this "umpire," the commission voted unanimously to dismiss its special engineer No. 1. A week later the commission approved the recommendations of the "umpire-engineer" for larger pipe. Since then there has been contention as to whether the dismissed engineer had a contract with the commission.

A careful study of the report of the "umpire-engineer" shows that it adds fuel for the flames of controversy and still further confuses the main issue—steel vs. concrete—by adding to the numerous side issues. We make bold to say that no layman on the commission or on the councils of any of the contracting municipalities, and no engineer except after long study could draw from the report sound, definite conclusions as to a number of the most important points in controversy, particularly safe watershed yield, and the advantages and cost of the enlarged twin-pressure aqueduct. Even more in doubt, and beyond the power of the best engineer to determine in specific figures without extensive local study, is what readjustment of allotted capacities and costs should be made among the contracting municipalities in view of the extended increases in delivery capacity due to the enlarged twin-pressure aqueduct plan, the chief if not the sole advantage of which would come through the delivery of flood flows otherwise wasted with no definite provision for their storage and possibility of economic storage seriously in doubt. The same need exists for further and impartial engineering study of the broad general claims for saving in pump lift in some of the high level districts, and the proposal to deliver water into a reservoir for discharge in turn through a pipe line, both privately-owned and serving communities, some of which are not in the water district for which the Wanaque is being developed. All these uncertainties should be eliminated, especially in view of the statement of the "umpire" that the smaller and earlier proposed pressure aqueducts would suffice to deliver the safe yield of the watershed. If so, how far is it sound engineering and economy to enlarge delivery capacity to carry flood flows that cannot be stored?

Finally, the North Jersey District Water Commission owes to its chief and consulting engineer and to the contracting communities a complete change in attitude. The communities should have the confusion worse confounded cleared up, so they may know what they are to get and what it will cost. They should be ensured of competition in the further contracts to be let. The commission's own engineers should be instructed to analyze the latest report and point out its significance. If any more outside engineers are engaged, both the commission's own engineers and the contracting municipalities should have a say as to their acceptability.

New Texas Railroad for Rock Island Lines

Large Agricultural Territory Opened—Oil Developments—Heavy Grading with Motor Truck Haulage—Combined Railway and Highway Crossing of South Canadian River

IN THE present active development of the "Panhandle" section of Texas, an important factor is the new 145-mile line of the Chicago, Rock Island & Pacific Ry., now under construction from Amarillo, Tex., to Liberal, Kan., and crossing the valley of the South Canadian. Construction is illustrated by the views herewith. As Amarillo (El. 3,666) and Liberal (El. 2,851) are on the Memphis-Tucumcari line and Kansas City-Tucumcari line respectively, the new connection will form a second and more favorable main-line between Liberal and Tucumcari, N. M. (El. 4,075), using 113 miles of the present line beyond Amarillo. These several lines are shown in Fig. 3. At Tucumcari, which is the end of the Rock Island System, connection is made with the Southern Pacific Ry., for through service to El Paso and Pacific Coast points.

A permit for the construction of the Amarillo-Liberal line was granted by the Interstate Commerce Commission in the spring of 1926. The portion now under construction, as authorized by the railway company, extends from Amarillo northeast 57 miles to Stinnett, the new county seat of Hutchinson County. By July, 1927, the line had been put in operation for 38 miles from Amarillo to Oil City, three miles north of the river. It is expected that it will be completed in October, 1927, and that the work will then be continued at the rate of 25 or 30 miles yearly, until the line reaches Liberal. This program gives opportunity for development of the country and will enable the heavier grading work to settle and consolidate before through traffic is handled over it.

Physical Conditions—Favorable grade and curve conditions are obtained by the new line. On the present route the maximum grades are 0.80 per cent between Liberal and Dalhart, and 1 per cent between Dalhart and Tucumcari. But on the new route, including the existing stretch beyond Amarillo, the maximum will be 0.60 and 0.50 per cent against southbound and northbound movements respectively, although the five-mile temporary line for a low-level crossing of the South Canadian River requires grades of 3.6 per cent. In alignment, the maximum curvature is 1 deg., except for the 20 miles across the South Canadian valley, where curves of 3 deg. are employed. On the temporary line mentioned above there will be curves as sharp as 10 deg. Beyond Stinnett, the maximum grade from the river crossing will be required for about ten miles, bringing the line up to the plains. Thence to Liberal the grades will be from level to 0.30 per cent, except for two stretches of about four miles each, crossing the Palo Duro and the Beaver rivers. When completed, therefore, there will be a high-speed low-grade line of easy curvature with low cost of operation for heavy freight traffic.

Agriculture and Industrial Development—Oil developments in the Panhandle oil field promise a heavy business for the new line, which was planned originally to open up new country and to serve as part of an alternative main line route. In 1925 there was a small production of oil along the south side of the South Canadian River, but by the time the permit for the new line was granted there had been a heavy development of oil. A great natural-gas field has been discovered also, south of the river, and plans have been prepared for the construction of gas pipe lines south to Amarillo and Lubbock, Tex., and north to Pueblo, Colo. Another probable development is in brick and glass manufacture, as brick clay and a large deposit of glass sand have been found along the river, about 35 to 45 miles north of Amarillo.

On the south of the river and also through the country known as the North Plains, on the north of the river, the line traverses what is probably the greatest tract of undeveloped wheat growing land that remains in this country without railroad facilities. It was expected that this land would become settled as a wheat, cattle and

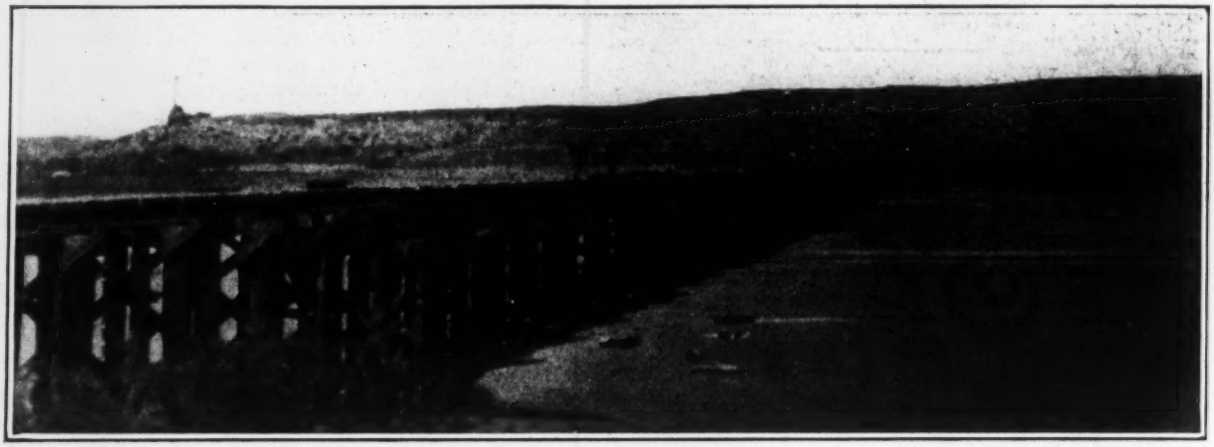


FIG. 1—SOUTH CANADIAN RIVER TRESTLE; C., R. I. & P. RY.

Downstream side. Channel portion has I-beam 28-ft. spans. Finished trestle has planked floor and railings for highway traffic.

dairy district. But the Panhandle oil field development has made a new picture. The outlines of this field have not yet been determined. There are good wells from five miles south to as far as 20 miles north of the river, with a possibility of their extending even farther. At the present time, therefore, attention is concentrated on the oil situation, but eventually the original expectation of a great agricultural district will probably be realized.

Canadian River Crossing—The South Canadian River flows between high steep banks, and a high-level steel bridge with rail level at El. 2,940, or 140 ft. above the river bed, is provided for in the plans. An interesting feature of this bridge, Fig. 5, is that it will provide for both railway and highway traffic. It will be a double-deck structure 2,430 ft. long, consisting of nine 250-ft. truss spans, with girders and reinforced-concrete trestles at each end to connect the roadway approaches with the lower deck, these approaches curving around the foot of the railway fills. On the upper deck will be a concrete slab floor with ballasted track, while the lower deck will have a concrete roadway slab with bituminous surfacing.

In order to utilize the railroad north of the river during the construction period, a temporary line has been built between miles 43 and 48, coming down from the south by a grade of 3.6 per cent to a low-level crossing with a pile trestle 1,800 ft. long, having its rails about 18 ft. above the river bed. Then the line rises at 2 per cent grade to strike the permanent line at Oil City, mile 49. This trestle, Figs. 1 and 4, is built to serve also for highway traffic. It has six-pile bents, with a guard pile on the upstream side of each bent as a protection against logs and drift. Over the main channel there are twenty 28-ft. I-beam spans; the remainder of the structure has standard 14-ft. trestle spans. The deck is widened and planked, as shown, to give an 18-ft. roadway for vehicles.

An exceptionally favorable site has been obtained for the crossing, with a bed of red shale extending across the river and overlain by only 15 to 25 ft. of sand, while elsewhere the sand is generally 60 to 100 ft. deep. This shale is about 165 ft. deep and forms a good foundation for the masonry piers. Furthermore, two layers of clay, each about 2 ft. thick, in the overlying sand, make the site favorable for driving the piles for the temporary structure. It has been suggested by Mr. Morse, chief engineer, that this site, with its shale bed and bluffs, would be favorable for the proposed flood-control dam. This dam might then serve to carry the highway and railway crossing.

It is expected that the permanent bridge will be completed at about the time of the final completion of the railroad. Its construction will occupy two years, the masonry being built between the flood periods of one year, and falsework being built and steel erected between the flood periods of the second year. In ordinary floods, the water at this point is 6 to 8 ft. deep, while with maximum floods the depth is about 12 ft.

Minor Structures—Very little bridging is required and the trestles do not exceed fourteen spans in length. They are of the standard design of the Rock Island Lines, of creosoted material, with five-pile bents spaced 14 ft. c. to c. and carrying open deck construction. Culverts are mainly of reinforced-concrete pipe, but there is one concrete box 10 x 12 ft. There are several stations at new townsites with standard track layout and

FIG. 2—HEAVY GRADING AT MILE 42 NORTH OF AMARILLO

FIG. 3—NEW TEXAS LINE OF C., R. I. & P. RY.

structures. Passing sidings 5,000 ft. long are provided at intervals of six miles.

Grading—On the first contract section of 42 miles there is about 2,500,000 cu.yd. of grading, with an average of 40,000 cu.yd. per mile for 20 miles and then 80,000 cu.yd. for the remainder of the distance. On the second contract section, 15 miles, the grading is approximately 1,150,000 cu.yd.; of this 225,000 cu.yd. is on the 5½ miles of temporary line, making an average of nearly 100,000 cu.yd. per mile on the remaining 9½ miles of permanent main line. Between miles 38 and 56 the work is very heavy, with cuts 50 to 65 ft. deep and fills 50 to 90 ft. high. The largest fill has about 220,000 cu.yd. and the largest cut about 77,000 cu.yd.

On the first 37 miles, the grading was let as team work on the pay-both-way basis, and classification in accordance with general specifications for solid rock, loose rock and earth. For the remainder of the line (with the exception of the temporary line), on account of the heavy work, it was specified as steam-shovel work and classified only as solid rock and earth. In earth that was harder than the average, it was given a percentage of solid rock with the idea of providing the same profit for handling this earth as would be made in handling the average earth.

The mere fact that the contractor shot or blasted the material was not considered as evidence of its being extra hard material, for the reason that the shovels used on this work were of continuous tread type and averaged only 25 to 50 tons in weight. This made it to the advantage of the contractor to shoot material in many cuts which with 65 or 70-ton shovels would not have required shooting.

Motor-Truck Grading—The material was hauled from the shovel to the embankment with motor trucks or wagons, but usually with motor trucks. Views of this motor-truck service in a deep rock cut and building a high fill are shown in Figs. 6 and 7. Narrow-gage construction track, with cars side-dumping from temporary trestles, was not used as the heavy work was about 45 miles from the nearest railroad, and hauling trestle material would have been costly.

For the light grading on the plains, the teams hauled fresno scrapers as a rule, but elevating graders were used to some extent, delivering the material to dump wagons with teams.

Track and Tracklaying — This new line is laid with re-rolled 100-lb. rails, which make about 90-lb. per yard. They are in 33-ft. lengths, with broken joints on both tangents and curves, and spliced with four-bolt angle bars. Treated ties are used, 20 to each rail length, with tie-plates on all ties. For the first 27 miles, gravel ballast is used. Beyond that the ballast is of caliche, a cemented calcareous material, of which a large deposit was found. With ballast 8 in. deep under the ties the quantity averages 2,650 cu.yd. per mile. Ballasting follows closely behind the tracklaying, the material being deposited by center-dump cars and leveled off by a pair of track ties laid across the rails in front of the truck of a loaded ballast car.

In tracklaying on the first 37 miles, a railway ditcher, with dipper removed, was used as the pioneer car at

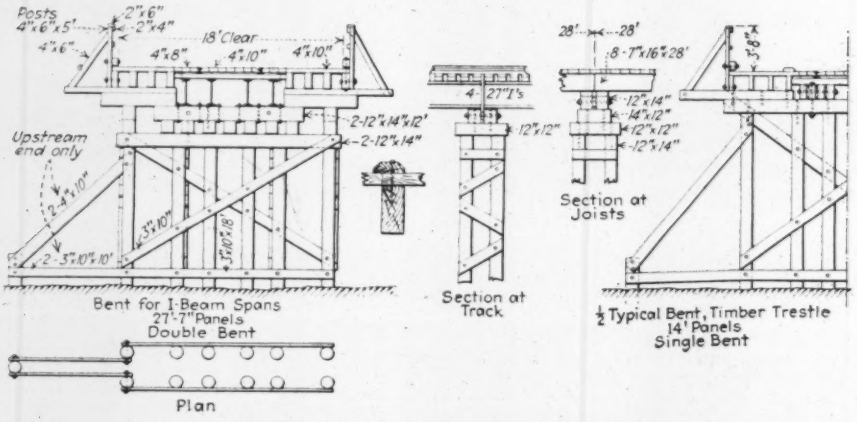


FIG. 4—COMBINED RAILWAY AND HIGHWAY TRESTLE

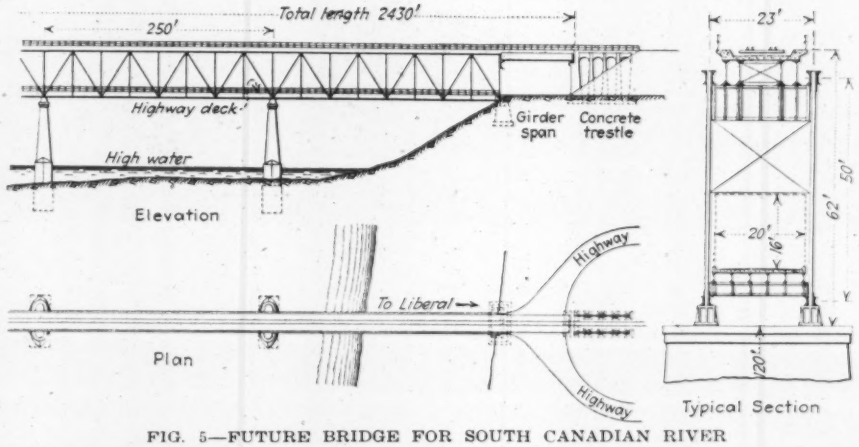


FIG. 5—FUTURE BRIDGE FOR SOUTH CANADIAN RIVER

TABLE I—TRACKLAYING WITH DITCHER; C., R. I. & P. RY.

2 Assistant foremen	4 On rail car, hooking clamp to center of rail
2 Strappers	4 Landing rail as lowered by ditcher
10 Spikers	2 Lining rails
5 Nippers	1 Peddling spikes
1 Joint clamp man	
10 Spacing ties	
3 Placing tie-plates	

TABLE II—TRACKLAYING BY HAND; C., R. I. & P. RY.

3 Assistant foremen	5 Nippers
2 On car, unloading rail	2 Liners
32 With rail tongs (16 on each side of track)	2 Placing tie-plates
	1 Peddling spikes
2 Strappers	10 Placing ties
1 Joint clamp man	2 Bolting
10 Spikers	1 Extra man

the head end of the material train. Next to this was a car with rails, sufficient for a half-day's work. Then came the locomotive, a car of splice bars, a car of tie-plates and a car of bolts, spikes and other track material. A separate trainload of ties followed. An unusual feature was the use of motor trucks to distribute ties and track material ahead of the train, about six trucks being used for this service. The organization of forces with this train is given in Table I. Behind the train was a force of 10 men bolting splices, 30 men back-spiking and 14 men loading ties on trucks.

Tracklaying by hand was used on the remainder of the work, on account of the number of cuts, in which it was difficult to swing the ditcher and its boom. The train consisted of two cars of rails, a car of miscellaneous material and short rails for curves, then the locomotive, followed by a car of splice bars and a car of tie-plates. With this train the force was as shown in Table II. Behind the train was a force of 75 men for the back work.

In laying track by hand, the track ahead of the train was half bolted and was spiked at joints, centers and quarters. When using the ditcher, work was expedited by placing only one bolt at each joint. This bolt was in the rear rail, the bars being fastened to the rail ahead by means of a bolt slotted to receive a wedge or taper key. This key bolt was quickly applied and was taken out by the men back-bolting behind the train. The bolts were carried ahead to the tracklayers as fast as they were removed, by the bolters. In fitting the splices, a special clamp was used to hold them while being bolted. The best day's record for tracklaying was 5,900 ft. by hand and 5,300 ft. when using the ditcher, the force being about the same in both cases.

Engineers and Contractors—The location and construction of this line were under the direction of Charles A. Morse, chief engineer of the Rock Island Lines. J. L. Adams located the line and is construction engineer. Tracklaying is being done by company forces under F. T. Beckett, district engineer of maintenance-of-way. G. L. Plow and J. T. Fitzgerald are the resident engineers. Walter H. Denison, of Cushman, Ark., is the general contractor for the first 58 miles, now approaching completion.

FIG. 6—GRADING IN ROCK CUT AT MILE 38

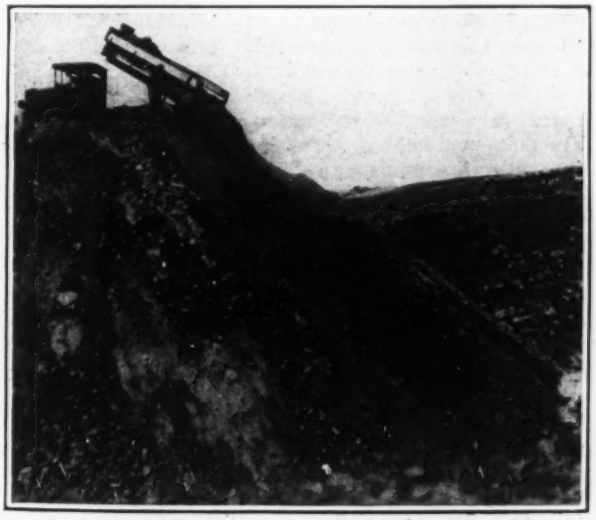


FIG. 7—MOTOR TRUCKS BUILD HIGH FILLS; C., R. I. & P. RY.

A Small Community Market Building

To facilitate the direct sale of farm and truck garden produce to consumers, a steel-frame community market building 104x225 ft. has been erected at Royal Oak, Mich. The building is designed also for revenue use as a convention hall and for automobile or truck storage, the market being held three times a week. Two rows of steel columns supporting the steel roof form a 70-ft. central bay and two 17-ft. side bays, all with a clear headroom of 12 ft. Brick walls with cast-stone sills extend to a height of 5 ft., above which the walls are of steel sash and glass, while the gable ends are filled in with 2-in. cement plaster. Cement tile covers the roof, except that each side has a continuous wire-glass skylight. Exhaust ventilators are provided on the ridge of the roof. In one end are two main doorways 11 ft. wide and 12 ft. high, fitted with vertical rolling steel shutters. Funds were provided by a bond issue and the market building was designed by R. J. Whitney, city manager. The N. A. Starr Co. was the contractor.

Fifth Article of a Series on
HIGHWAY MAINTENANCE

Determining Snow Removal Requirements

By V. R. Burton
Engineer of Research and Statistics, Michigan State Highway Department, Lansing Mich.

MICHIGAN, with the possible exception of New York, has a more varied snow problem to deal with than any other state outside of the western mountain states, due to the fact that the state consists of two peninsulas with water on three sides of each between latitudes 41° 45′ north to 47° 30′ north. There is a variation in climate in a single state seen in no other state except where such change is due to altitude and not latitude. The airplane distance from Detroit to Ironwood is about the same as from Detroit to New York City, Nashville, Tenn., or St. Louis. The northernmost point of the Keweenaw peninsula is in about the same latitude as the northernmost tip of Maine, and the southernmost point at Monroe is equal in latitude to Providence. The snowfall ranges from an annual average of less than 30 in. in Adrian to 130 in. in Calumet. Temperature variations are almost as extreme. Zero weather is quite uncommon in Monroe, while in Humboldt—in the Upper Peninsula interior—a temperature of 50 deg. below zero was officially recorded last winter.

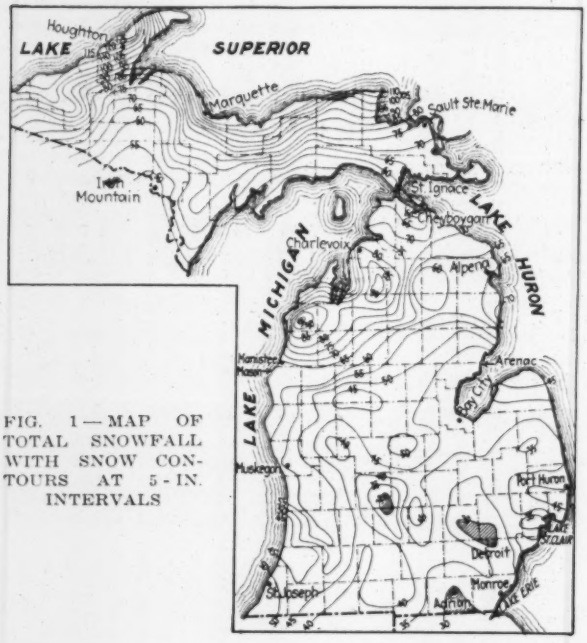


FIG. 1—MAP OF TOTAL SNOWFALL WITH SNOW CONTOURS AT 5-IN. INTERVALS

In the winter of 1922-23 it became evident to the state highway commissioner that a big increase in the amount of mileage covered by snow removal program was imminent. A careful study of the whole snow removal problem was ordered, which was to include a study of the Michigan situation, of methods and equipment suitable to the various sections and some idea obtained of the cost to be expected in sections of the state at that time not covered by snow removal. Much of the following material is a development of this study.

Volume and Character of Snowfall—To have an intelligent idea as to the manner in which snow removal problems should be met, we must first consider those elemental forces of nature which operate to make snow removal necessary. First is the amount of snowfall over the various sections of the state; second, the temperature during those months in which snow removal is necessary; and third the velocity and direction of the wind. Of these three factors the only one whose effects can be directly modified by man is the wind. The U. S. Weather Bureau records were consulted for information which might have a bearing on this problem and the following useful information was found: (1) The total snowfall unmelted; (2) snow on the ground; (3) mean temperature; (4) maximum and minimum temperature variations from the mean; and (5) the mean direction and velocity in miles per hour of the wind.

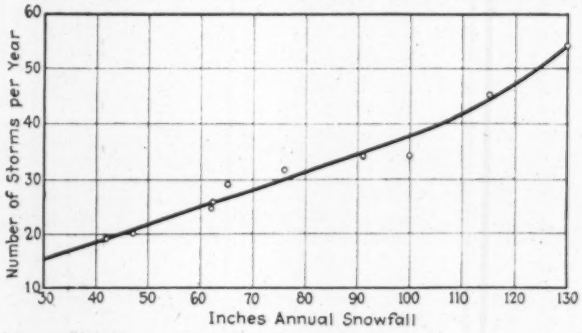


FIG. 2—NUMBER OF SNOWSTORMS EXCEEDING ½ IN. AT VARIOUS RATES OF TOTAL SNOWFALL

A little thought will convince anyone that the total annual snowfall is of comparatively little value in itself. The only snowfall of interest in our study is that which falls at such a temperature that it will not melt immediately but stays on the ground and must be removed. The amount of snow moved, therefore, will not vary according to the total snowfall, but only with the snowfall as affected by temperature during the colder months when removal becomes necessary. Information on total annual snowfall is useful because certain conclusions concerning rates of fall and storm frequency depend on the amount of total annual snowfall, but this picture will not give an adequate idea of the removal problem unless all other factors are considered. In this study of the climatic factors influencing snowfall nothing but averages is used and no station records were used at which less than a ten-year record was available. It follows therefore that the conclusions drawn from a study of these averages will give average results, and cannot be applied to individual years. We can, however, by a study of these averages, state definitely that in the long run the conclusions drawn are probable, though no one who has had any experience in snow removal will venture to say

that a study of snowfall records will enable a man to predict the amount of snowfall which will take place in any locality during the coming removal season.

A map of the total annual snowfall in Michigan is shown, Fig. 1, with the snow contours at 5-in. intervals. In the lower peninsula there are three areas (shaded on map) of less than 30 in. In general the amount of increases from east to west in those counties south of the tier from Mason to Arenac counties and varies from 35 in. on the east side to 55 or 60 in. on the west side. North of this tier of counties the amount varies from 65 in. on the east coast to 90 to 95 in. in the heavy snow belt ranging from Charlevoix to Manistee County.

The upper peninsula snowfall varies from a minimum of 50 in. on the south side to a quite general amount of 110 in. on the north side, with 118 in. at Marquette and 130 in. at Calumet. Lake Michigan and Lake Superior have a marked effect on the snowfall, as the winds blowing over these lakes collect a large amount of moisture which is deposited on reaching the cooler land areas along their shores, and the lakes are directly responsible for the greater amount of snow found in Michigan above that of the neighboring states.

The manner in which the snowfall is distributed throughout the winter influences the method of handling the removal problem. Certain questions must be answered: How much snow falls, and how often and with what intensity do snow storms come? How much of the removal is due to large and how much to small towns? What percentage comes in storms so small that snow removal is unnecessary? In the following study it has been assumed that snow removal is not necessary for snowfall less than ½ in. Intensities of 1 in. represent an average of the snowfalls from ½ in. to 1½ in. and the number of storms of 1 in. intensity include all of those ranging from ½ to 1½ in. The 2-in. intensity ranges from 1½ to 2½ in. and so on. Fig. 2 shows the annual number of snow storms at various rates of total snowfall. It will be noted that the total number of snow storms in any year is not large. Even where the snowfall averages 130 in. the number of snow storms over ½ in. in intensity amounts to only 54, and throughout a whole range the snow deposited by the average storm is only about 2¼ in.

The violence of snow storms has been greatly exaggerated. Fig. 3 shows the years period between storms of certain intensities. Storms above 6 in. in intensity are comparatively infrequent, averaging about one per year in the heaviest snowfall district in the state. From this diagram the heaviest annual storm which may be expected at Calumet is 6½ in., Ironwood 6¼ in., Houghton 5¾ in. and Escanaba 4½ in. The 12-in. storms of which we frequently read in the newspapers occur in Escanaba and Calumet about once in fifteen years, in Houghton and Ironwood once in seven years. The heaviest snowfall recorded was one 24-in. storm in Ironwood in a 20-year record.

To emphasize further the large amount of snowfall from the smaller storms, Fig. 4 has been prepared showing the amount of snowfall below and including the intensities given. The largest variation occurs below and

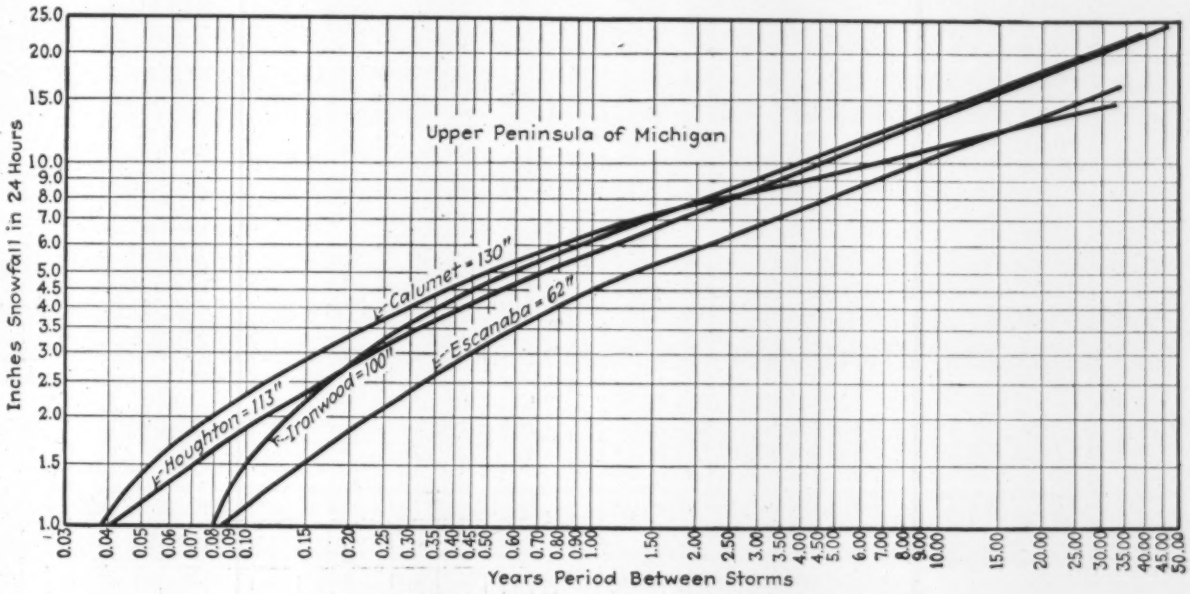


FIG. 3—FREQUENCY OF SNOWSTORMS OF VARIOUS DEPTHS

including the 1-in. intensity; the least amount, about 18 per cent, is at the 100-in. total; and the maximum at the 30-in. total at about 43 per cent; the variation in these percentages growing smaller to the 6-in. intensity when there is only about 2.5 per cent variation in the percentage of the total snowfall for total annual snowfalls of any amount. About 85 per cent of the annual snowfall for any range of total annual snowfall comes from storms of less than 6-in. intensity. From the lowest to the highest snowfall in the state the major amount is derived from small storms and, counting storms of all amounts above ½-in. snowfall, the number varies from but 19 to 54. Snow falling quietly on the level, if no other factors were introduced, would be comparatively easy to handle and there would be no serious snow removal problem.

Effect of Temperature—In Michigan at a mean temperature of 24 deg. the maximum temperature will be 32 deg. and hence some thawing will occur. As a matter of fact, in direct sunlight some thawing will occur even at a temperature below this. Besides the direct thawing and melting there is a further loss by the sublimation of dry snow. Freezing will begin at a minimum temperature of 32 deg. which in our climate occurs at an average mean temperature of 40.7 deg. The periods during which these

mean temperatures vary between the daily mean of 24 deg. and 40.7 deg. are therefore important in determining when snow removal is necessary. Snow falling when the mean temperature is near the upper limit will not remain on the ground long, while near the lower limit it will remain in place long enough to so make removal necessary.

After snow starts to fall in a storm as it gradually accumulates settlement takes place due to the increasing weight of the snow. Therefore the measurements by which snowfall records are made take into account to a certain extent this settlement due to weight alone. As storms frequently lap from one period into the other during which snowfall records are taken, no reduction due to temperature alone can be surely counted on until sufficient time has elapsed to insure a cessation of the storm. Also, a rise in temperature is more apt to follow the storm in those periods when the mean temperature for that period is higher than that at which snow ordinarily falls. The 48-hour period following the first record of a snow storm has therefore been chosen as the period in which most of the snow reduction takes place. A longer period than 48 hours evidently gives results quite different than the immediate reduction of new-fallen snow. After the initial compaction, reduction decreases, and an attempt to get an average reduction over any longer period gives erratic results. What we wish to know is, the reduction in depth of snowfall from temperature alone by actual melting and evaporation. The larger snowfalls suffer greater reduction due both to their weight and to the fact that water from the top running down through the snow beneath has a greater effect in melting it.

To establish the relation between the reduction in snow depth and mean temperature the daily record of snow on the ground from the East Lansing weather bureau extending back over the past 14 years was used. The amount of snow reduction for the 48-hour period following the first record of the storm was plotted against the mean temperature during this 48-hour period. Instead of using all the points in determining the curve of snow reduction, the average for each mean temperature was plotted and the curve drawn. As a matter of fact, the reductions given were uniformly about 0.4 in. greater than that shown on the curve throughout the whole range of temperature, but this amount is due to weight settlement and not to any actual disappearance from melting or evaporation. The base line was therefore used as shown, and reduction as considered in this study means the amount which actually disappears, Fig. 5.

To apply the results from this station and other stations, conditions regarding average depth of snowfall per storm must be about the same. This is actually true, as 90 per cent of the snowfall at all stations is in amounts less than 6 in. As all other factors are absolutely independent of total annual snowfall or anything else except the actual snowfall and temperature immediately with and following a storm, there has been obtained the means to go into a much more detailed study of the local conditions affecting snow removal in every section of the state.

A definite relation has now been determined between temperature and that part of the snowfall which must be moved. The curve giving this relation in Fig. 5 shows that temperature effect is small below a 20-deg. mean. This is consistent with the statement that, in the relation between maximum, mean and minimum temperature, the temperature did not reach 32 deg. maximum below about 24 deg. mean. From 20 to 32 deg. the amount of reduction varies 0.15 in. to 1 in. in 48 hours.

Information is now at hand which will enable us to predict at what temperature snow of various depths will disappear within a short time after the storm. If this is correlated with the actual time periods during which the average temperature and snowfall are both known it will be possible to predict the length of the removal period and the actual amount of snow to be removed on an average. If a continuous curve is plotted showing the variations of temperature and snowfall over the removal period, separated into time divisions, at any weather bureau station, intermediate values by interpolation will show very closely the conditions at any desired time. If, on the same time basis, the amount of snow reduction during the period under consideration is plotted, the point at which snowfall exceeds snow reduction shuld mark the beginning of the removal period, and the point at which snow reduction again exceeds snowfall should mark its end. This was done for each one of the

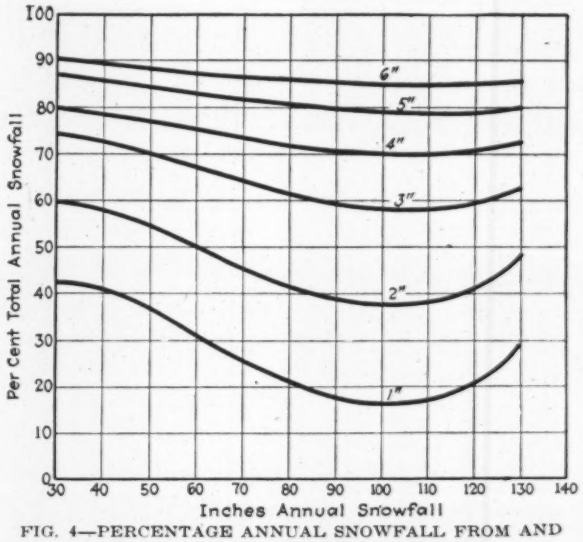


FIG. 4—PERCENTAGE ANNUAL SNOWFALL FROM AND BELOW STORMS OF GIVEN INTENSITY

weather bureau stations, an example of which is shown in the curves for Calumet, as given in Fig. 6.

The months are all assumed of 30-day length divided into three 10-day periods. This time interval is accurate enough for our purpose as it gives results within a few days the same as if 5-day intervals were used. Readings were interpolated for the nearest five days, however, using the 10-day period as the unit on our time scale. The actual dates are shown and temperature, snowfall and snow reduction data plotted as of the 5th, 15th and 25th of each month for the 10-day periods from the 1st to the 10th, 10th to the 20th, and 20th to the 30th of that month. Care was taken to keep the sum of the 10-day ordinates of the continuous curve of snowfall equal to the mean monthly snowfall. In the same way the temperature average for the 10-day ordinates is the same as the monthly average. The snow reduction ordinates for the same 10-day period are obtained by multiplying the 48-hour reduction at the given temperature by 5.

The Calumet curves show that the snow removal

season begins about Nov. 15 and ends about April 1; snow falling before and after this period completely disappears in less than 48 hours. The sum of the 10-day ordinates of the reduction curve gives the amount of snow disappearing during the removal season. It is of course true that snow falling throughout the winter, or temperatures recorded, will not follow any such regular curves as those shown. Cold weather may start early in the fall so that snow that falls will remain all winter, or thaws may completely eliminate snowfalls in the midst of the removal season. A curve of the conditions for any one winter would be much more irregular than the average curves shown, but on the average as much snow reduction as is given by this method will occur each winter from melting and evaporation within at most 48 hours after the storm starts.

Direct comparisons can now be made between sections of the state widely different in conditions of temperature and snowfall if reference to the wind is omitted. The actual length of the removal period as predicted by our temperature and snowfall study is verified very closely by the experience of men engaged in snow removal about the state and from the state highway department's own observations.

So far as snow unaffected by drifting is concerned and the lengths of time during which removal must be done, a fairly complete picture of conditions throughout

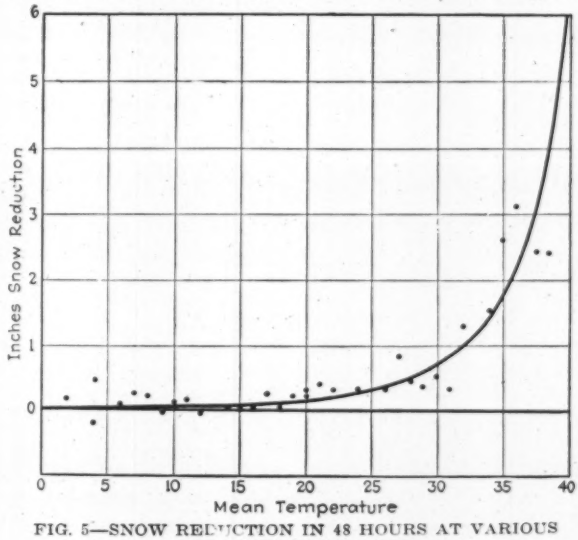


FIG. 5—SNOW REDUCTION IN 48 HOURS AT VARIOUS MEAN TEMPERATURES

Michigan has now been obtained. Maps showing the beginning and the end of the removal period have been prepared from information obtained from weather bureau station curves similar to those for Calumet. Each station was considered separately and the results plotted. Instead of the regular contour method, the areas in which snow removal is likely to begin or end on the date shown were outlined from these data.

Fig. 7 shows the map prepared for the beginning of the snow removal period. In the upper peninsula in western Gogebic and Ontonagon counties and in the western part of the interior of Marquette county removal starts about Nov. 10. By Dec. 1 the remainder of the peninsula will in the average year be doing removal work except for a small area just around Menominee. Removal work in the lower peninsula starts in the northern interior about Nov. 15 and gradually moves south until at about Dec. 20 snow removal work is on over the entire state. It is admitted that showing these periods to the nearest five days is an unnecessary refinement from the standpoint of the practical beginning date of the snow removal period, but they give a better indication of the fact that there is an actual difference in the average removal conditions even in comparatively limited areas. Unless this difference were shown results would not be entirely consistent with conditions as they are. It is perfectly evident to anyone

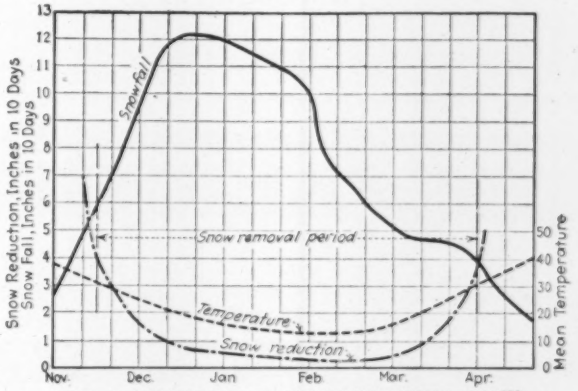


FIG. 6—EXAMPLE OF GRAPH SHOWING SNOW REDUCTION PERIOD

that conditions from year to year may vary widely from these averages.

Fig. 8 shows the end of the snow removal period. Beginning about Feb. 25 in the southeastern corner of the state, the removal area moves northward until by March 20 the lower peninsula is free from further work of this kind. On March 20 two small areas in the upper peninsula are through and the area moves westward until by April 5 in the interior of Marquette County the season finally ends.

Wind Effects—The average wind velocity during the snow removal period is considerably higher in the lower peninsula than in the upper peninsula, and in general the stations on the lake shores show a considerably higher average velocity than those in the interior. No one, however, who is at all familiar with the facts would claim that the drifting in the different sections of the state varies according to these average wind velocities. It is a matter of common knowledge that the drifting in the colder sections of the state is much more serious than in the warmer sections to the south even though the average wind velocities are considerably lower. The fact, then, that the temperatures are usually higher along the shore than they are in the interior more than compensates in many cases for their higher wind velocities. The only useful comparisons which could be made using wind velocities would be in places of similar temperature and snowfall.

Throughout Michigan the average wind velocities vary from 7.4 miles per hour to 13 miles per hour. Observations at the state highway department experimental snow station last winter showed that snowfall accompanied by wind of over 20 miles per hour caused considerable drifting. Wind of lower velocities did not cause such serious drifting. This simply serves to show that no useful information can be obtained from a study of average velocities.

Correlation of Factors—All the elemental factors affecting snow removal have now been discussed and it

remains to correlate them. The greater proportion of snowfall in all sections of Michigan is from the smaller storms. A definite relation between temperature and snow reduction has been worked out and gives not only the amount of snow to move in the period shortly after the storm but even the length of the average removal season. Now it remains to apply our knowledge of the snow removal factors in a connected way to the specific problem of the individual county.

That part of the total annual snowfall which does not have to be removed comes under three headings: first, the snowfall which comes outside of the removal period and disappears shortly after it falls; second, the amount which actually disappears during the removal by melting and evaporation before or during the time at which it is moved; third, smaller snowfalls in the warmer sections of the state where drifting conditions are not so prevalent. These amounts should be considered in determining just what proportion of the total annual snowfall is actually moved off of the highway.

The snowfall outside of the normal removal period usually occurs when the temperatures are so high that complete disappearance occurs in less than our standard of 48 hours. We shall therefore subtract this entire

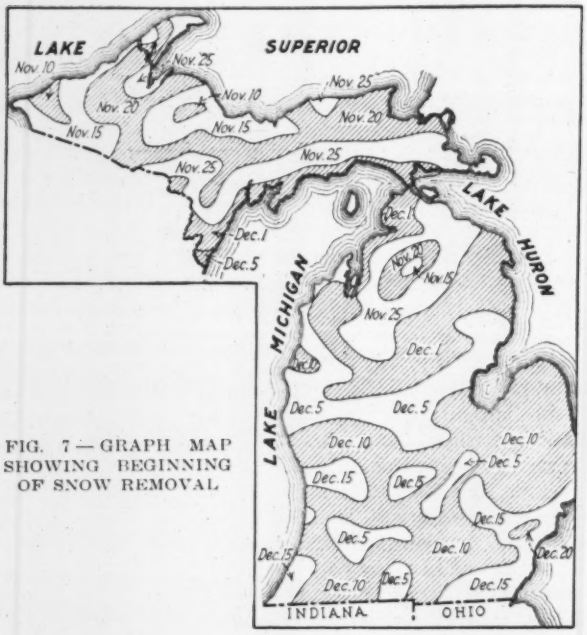


FIG. 7 — GRAPH MAP SHOWING BEGINNING OF SNOW REMOVAL

amount from the total annual snowfall to get the amount actually moved.

The station curves show that the major part of the reduction during the removal season occurs in the early and late parts of the season; its percentage of the total annual snowfall is small in the colder part of the state but is greater in the warmer sections. A few years ago, in figuring the amount to subtract for this cause, the entire amount of reduction was used. This was probably correct in the northern part of the state due to the long period taken in removal. Modern methods have shortened the time so that the average reduction throughout a 48-hour period or one-half of the maximum should now be used.

In the warmer portions of the state the snowfall coming from small storms that do not necessitate removal should be subtracted from total annual snowfall to give the total amount removable. Comparison of the total removable snow to be expected annually in a locality with the average cost of removal in that locality over a period of years should give an inch-mile cost which would be a dependable value for a snow removal cost unit. These cost units do not take into account anything but quietly falling snow unaffected by the wind and therefore will reflect a factor introduced by drifting. As our methods of drift prevention improve, this fact will be of less and less importance.

One of the most important factors affecting cost of snow removal is the amount of snow remaining on the ground. As the banks build up during the winter the

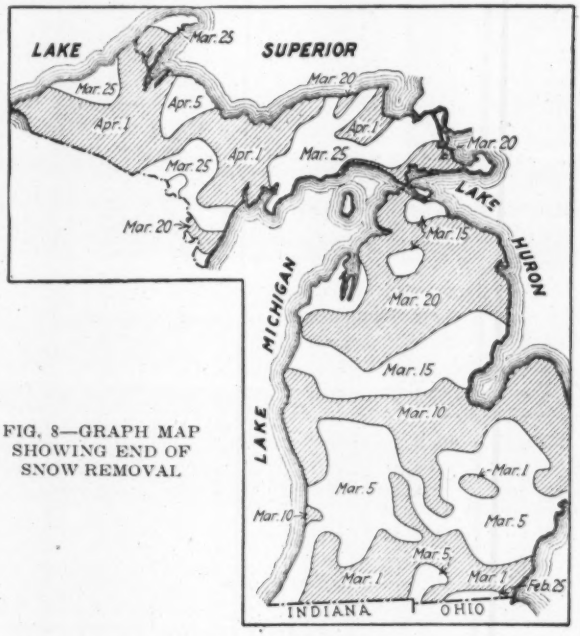


FIG. 8—GRAPH MAP SHOWING END OF SNOW REMOVAL

snow must be lifted higher and higher. Drifting is more serious due to colder temperatures and to the increased depth of snow cut. Quite commonly, this year, from a half to two-thirds of the snow in Michigan fell before the first of January. Costs generally for the months of November and December only run about a quarter of the total cost of removal up to the first of April. The decreased cost of early season work is due to the greater snow reduction, less drifting, and to the low banks which permit the use of light equipment. The effect of the snow on the ground on snow removal costs is being worked out but results are not yet available.

The next article will be "Snow Removal Methods and Equipment," by Mr. Burton, author of the present article.—EDITOR.

Pondage as Factor in Spillway Design

In the article, "Pondage an Important Factor in Spillway Design," by Melvin D. Casler, published in *Engineering News-Record*, July 28, 1927, there were the following typographical errors: On p. 133, column 2, "Let d = depth of water on the weir crest," should read "Let d_y = depth . . .;" and in Table I the headings of columns 4 and 5 should be, respectively, q and $S + q$ in place of Q and $S + Q$. Besides these, the word "restricted" should be omitted from the heading of Table III and from the caption of Fig. 3.

Notes on the Near East

By An Engineer

By C. E. Grunsky
Consulting Engineer, San Francisco, Calif.

MODERN Egypt is conducting its agriculture, much of its transportation, and its sanitation with the tools and standards set by the overseers of the Pharaohs. The new national spirit seems to be expressing itself more in a flair for politics than in practical accomplishment, although it is still early to predict what the policies of the quite young native government will be. There is certainly a definite move toward extending education and an attempt is being made to give the peasantry some idea of the rudiments of sanitation. But in a land where sewer systems are almost unknown, where drinking water is dipped from rivers, ditches, ponds and shallow wells and carried in jars or skins, and where much of the irrigation water is still raised, as in the time of Rameses, by the shadoof, progress is bound to be slow. The control of the Aswan dam has now passed to the Egyptians but the manipulation of its gates and the regulation of the flow of water in the lower Nile is still by British engineers.

The narrow strip of the Nile valley is extremely fertile and is zealously tended with a vast amount of labor. Its yield per acre could probably not be increased, but by resorting to more modern methods of lifting water to higher elevations there is a possibility of bringing additional areas under cultivation. In one or two localities, such as at Kom Ombo and below Assyut, foreign companies have installed pumping plants and are working extensive plantations with apparently excellent results. About thirty villages are located in 30,000 acres of improved Kom Ombo land where but a few years ago there was only desert.

Economic problems, such as providing for the fellaheen, whose occupation would in large measure be replaced by the installation of labor-saving devices, undoubtedly stand in the way of modernizing farming operations and methods of living. The country as a whole, in spite of its antiquity, presents a picture of frontier conditions and undeveloped possibilities. Inevitably the future will see tremendous changes which will be largely engineering in their nature.

Palestine, under British mandate, is showing signs of progress. Here, too, much of the plowing is still done with the curved stick and sanitation is still primitive. In spite of the scanty soil and the frequent failure of crops by reason of insufficient rainfall, there is practically no irrigation except a little near Jericho. Neither is there any conservation of rainfall for domestic use except where roof water is led into cisterns. Up to a year ago even Jerusalem received its water supply from rain water cisterns, supplemented by a little water drawn from wells and a few small springs. The most notable of these springs supplies water to the so-called Solomon's Pools which lie several miles from the city toward Bethlehem. During the dry season of 1925-26 these sources of water almost completely failed and Jerusalem, with its 80,000 population, was left dependent on water shipped in by railroad.

Under the stimulus of British enterprise, water has been pumped to Jerusalem from Ain Farah since June, 1926. This is a spring which supplies 0.22 to 0.25 m.g.d. It is about 18 miles northeast of the city in a picturesque limestone canyon. That the spring served in Roman times is clearly evidenced by remnants of an old aqueduct, a small supporting arch, and an intake pressure—or regulating—chamber. As the spring is far below the level of Jerusalem, pumping is necessary. The water is raised at three stations by 5-stage centrifugal pumps, the lift at each station being a little over 600 ft. and the total lift to a service reservoir near Jerusalem 1,860 ft. The pumps are operated by belt-connected Diesel engines.

The force main is 8-in. wrought-iron pipe with a circumferential bead at the end of each length. The ends are butted together and covered with a rubber sleeve, above which a light cast-iron sleeve is bolted. The joint is quite flexible and makes special provision for expansion unnecessary. No trench was excavated for the pipe because this supply is intended to serve for only two or three years, until a permanent supply is brought in from near Jaffa, and also because excavation would have been in firm limestone which has a soil cover of a few inches in places. Some protection is afforded to the pipe by laying loose rock around it. The pipe line is commendable for its adaptation to local conditions. It was laid within two months, but after a road closely paralleling the pipe line had been built. All material was imported from England. Sir Jackson, Ltd. of England, represented by F. de C. du Santoy, laid the pipe line for the Public Works Department of Jerusalem.

TRANSPORTATION OF BUILDING STONE

Blocks of stone each weighing 450 lb. were raised by four men to the back of the bearer who, barefoot over very uneven ground, carried his burden about 200 ft., his four companions accompanying him and steadying the load when needed. The photograph was taken at the Citadel, Jerusalem, where excavations are in progress. This is typical of other methods such as carrying blocks of stone which are to be broken for macadam in slings across backs of donkeys.

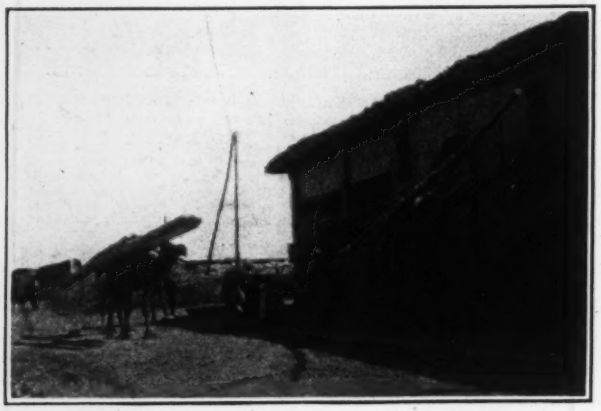
The Ain Farah water supplies about 3 gal. per capita which is still supplemented with the water from wells and rain water cisterns and small reservoirs, dating back to the time of Solomon.

The sewer system of Jerusalem is as yet confined to the newer European section of the city.

Modern roads in Palestine consist mainly of highways between the larger cities. They are in good condition. Passage over other roads, such as a graded track to the Dead Sea and the Jordan River, branching off from the Jericho road and leading through the alkaline flats and

hummocks of the Jordan Valley, should not be attempted during or too soon after a rain. Both in Palestine and in Syria on the roads to Damascus careful attention is given to maintenance. There is plenty of good road-building material near at hand. Rock gathered from the fields is broken to macadam size by small hand hammers and kept on hand for use wherever required. Women, as well as men, find employment on road work and in sections where farming is particularly difficult, the road work contributes to the family income.

That some use should be made of the water of the Jordan, which now evaporates to the amount of 500,000 acre-ft. or more per annum after reaching the Dead Sea, is obvious. Apparently some land in sizable tracts, such as the flats which flank the lower end of Lake Tiberias and extend down the Jordan valley, is available and would justify irrigation. The government has granted a concession for the regulation of the stream flow by means of storage with the development of power on the upper Jordan, and it is understood that actual construction work on this project is soon to commence. The ultimate purpose is said to be the utilization of Jordan river water for irrigation. The concession has been given to a Mr. Rutenberg and associates, with recapture provisions at the end of 50, 75 and 100 years. It is understood that the government will share in some measure the profits of the enterprise. Electric power and distribution operations have already been commenced by Mr. Rutenberg, consisting thus far of steam plants located at Jaffa, Haifa, and Tiberias. The expenditure of $1,250,000 during the last few years on these plants and a reported net income in the Jaffa section alone of some $150,000 per annum, may be accepted as a good



TRANSPORTATION OF 10-IN. POLES, 30 FT. LONG AT DAMASCUS

Two poles are a camel load for which a wide swing must be taken into account, particularly when the camel negotiates a street corner.

indication of further progress on this project at an early date. The project calls for a reservoir above Lake Tiberias with an initial hydro-electric development at two power stations, each with a 25-m. head and a capacity of about 25,000 horsepower.

Syria, under French mandate, has suffered almost constant internal disturbances, culminating in a rebellion now happily a matter of the past, yet so recent that many of the barricades and improvised shelters for the troops are still in place in the streets of Damascus. Roads have been improved throughout the country and are kept in fair condition, even in the region across the Lebanon mountains, where there is much resurfacing contemplated. Neither in water supplies nor power development has much yet been done.

Beirut may be cited as an illustration of how completely a city of the old type can be transformed. It has crooked narrow streets flanked by antiquated hovels. Property was taken by appropriation and new streets were laid out regardless of old alignments. The business section of the city is rapidly becoming modernized and is taking on a European appearance. An attempt has been made to wipe out the evil of small land holdings

PUMPING STATION AT AIN FARAH

Temporary water supply project for Jerusalem. The station tank or sump is rectangular with inside bracing and when partially filled has its water surface above the level of the pump.

resulting from the Mohammedan system of equal inheritance among children. Generations of this division of estates have resulted in the land being subdivided into holdings sometimes of only a few square feet. Any change in ownership necessitates most laborious tracing of titles of doubtful validity. Some readjustment of ownership, after new streets were planned, has been effected by joint or syndicate ownership of larger tracts.

Turkey has greater agricultural possibilities than the other Arabic countries, but like them its resources are largely undeveloped. The slogan of the young Turks, as personified in Mustafa Kemal Pasha, is "Westernize!" The government has the most modern regulations as to education, health and sanitation, although little has yet been accomplished. Activity centers largely in agriculture. The government has established a model farm. An American tractor company reports over 1,000 of its machines now in use, although before 1921 they were unheard of in Turkey. The Germans seem to have started this development by making the station masters of the Bagdad railway also sales agents of farm machinery. The government and Americans have continued this process of education by establishing schools for auto mechanics throughout the country. Robert College, at Constantinople, an American institution, specializes in engineering training and reports increasing interest among the Turks in its courses, especially in a short training course for mechanics.

The transfer of the capitol from Constantinople to Angora has presented problems of engineering interest, as it involves the introduction of modern water supply and sewerage systems. Unfortunately, the native system of graft in awarding contracts and executing public works has not yet been altogether abandoned, and as a

consequence the work to date is reported to have resulted in but little accomplishment from comparatively large expenditures. The intricacies of government red tape, in fact, combined with the evident desire of the new regime to keep the work in its own hands, has largely kept American contractors and capital out of the country. But the Turk's attitude in this regard is reported to be changing and in all probability the next few months will see American engineers called in to carry out some of the more important projects.

It is astonishing how Constantinople with its million inhabitants can exist with its primitive sanitary arrangements. Electricity is known in only three or four of the larger cities, electrical equipment is used to a very limited extent, and conservation of water for irrigation or power development is almost unknown. The country still suffers under its post-war burdens which were greatly augmented by the loss of the industry of about a million Greeks and Armenians, who were banished from the country. The tax burden is onerous. Nevertheless, progress is the order of the day. Opportunities for future development are good, especially in the fields of agriculture and road building. City water supplies, water conservation and other utilities will follow gradually.

Report on Chicago's Water Meter Controversy

Water Surveys to Check Consumption Proposed by Opponents of Universal Metering—War Department's Position

A PAMPHLET on the proposed substitute for the present universal-metering ordinance at Chicago, issued by the Department of Public Works, opens with a letter to the finance committee of the city council by R. W. Wolfe, commissioner of public works, recommending the passage of the substitute ordinance and stating that the proposed plan will accomplish the same result in less than half the time and with considerably less expenditure.

It is planned to reduce the water consumption per capita for all purposes to 185 gal. per day and to accomplish this in five years by the following means: (1) Complete pitometer surveys to locate general leakage and waste; (2) an underground leakage survey to stop leaks in mains, cut off unused services and put valves in operative condition; (3) house-to-house inspection to detect plumbing leakage, with strict enforcement of the ordinance; (4) periodical surveys and inspections covering the previous features; (5) metering every commercial and residence service where the assessed rate is $40 or more per annum, or where the commercial establishment has a service pipe 1½ in. or more in diameter; (6) metering services where there is waste, neglected leakage or unusually large usage; (7) periodical inspection and tests of meters.

To carry out this plan it is proposed to organize a special division in the bureau of engineering under an engineer ($6,000), with a force of about 427 (including 330 laborers) and an annual wage list of $976,728.

The "probable" distribution of daily pumpage at the present time is given as follows in a report by Mr. Biossat, an attorney appointed by the mayor as a special assistant corporation counsel to handle this matter, which report occupies the greater portion of the pamphlet: Commercial and industrial, 75 gal. per capita; domestic, metered and unmetered, 83; free water, 12; parks, 6; leakage and waste, 109; total, 285 gal. per capita. He estimates that the commercial item would be reduced to 72 gal. by metering and that the leakage and waste item would be reduced to 12 by the water-waste surveys, making a total of 185 gal. per capita.

The attorney states that the late John Ericson, as city engineer, "failed in his duties to mitigate leakage and waste by means other than meters, that were at his command." There are other attacks upon Mr. Ericson and the bureau of engineering, and also upon the value of meters in reducing water consumption.

Meters installed in 1926, according to this report, numbered only 14,851, although 40,000 per year was the number required to comply with the universal-metering ordinance. Reasons are not given in the report, but various statements in the daily press have indicated that the slackness has been due to labor troubles and to political and other opposition. The cost of universal metering is said to be "variously estimated" at $12,000,000 to $20,000,000, so that "if 400,000 meters are set in the next ten years, the total cost will be approximately $16,000,000." The report states further that 11.6 per cent of the services are metered and that over one-third of the people are supplied with metered water due to the policy of metering large users and large apartment buildings. An appendix consists of an article in *Engineering News-Record* (April 10, 1919) on the reduction of water consumption at Newark, Ohio, by means of a water-waste survey.

A five-year program for the Chicago water survey is proposed, each year to include 40 sq. miles of new area and a resurvey of the previous area. The program would begin anew on the sixth year. The cost is estimated at $1,280,028 for the first year and $1,244,028 for each succeeding year, making a total of $6,256,140. For the new division in the department of public works, the force and appropriations are listed by the attorney, but the commissioner of public works cuts the figure for the engineer in charge to $6,000; the total given includes $9,900 for use of eleven personally-owned automobiles:

	Force	
Engineer in charge	1	$8,400
Water survey section	60	185,760
Underground leakage section	315	652,990
Office section	23	43,740
Supply section	17	51,188
Meter test and control section	14	37,050
Total	24	$979,128

As to the attitude of the War Department, the attorney reports that he had a conference with General Herbert Deakyne, assistant chief of engineers, U. S. Army, with the following result:

"General Deakyne stated that we could proceed with modification or redrafting of the present ordinance, eliminating universal metering and that if the city carried out the plans submitted in the report, that such action on the part of the city would be regarded by the War Department as a partial compliance with the prior agreement with reference to meters, and that the War Department would say nothing and do nothing in the matter as long as said plan was carried out, with the idea that the decision of the Supreme Court would satisfactorily decide the whole matter."

Bristol Dam Designed for Later Height Increase

Buttresses for Higher Structure Built Into Power House Section—Increased Pressures Considered in Intake and Valves

By W. D. Henderson
Assistant Engineer, Jackson & Moreland, Boston, Mass.

FUTURE increased capacity of hydro-electric plants is commonly obtained by providing for later installation of additional generating equipment. The more uncommon provision for increasing the dam height at a later date to increase the head is a feature of a plant built by the Utilities Power Co. at Bristol, New Hampshire, on the Pemigewasset River.

In its general arrangement the plant is not unusual. At the site the stream flows between rather steep banks so that the dam is comparatively short, 520 ft. overall. The power house is close to the dam and in fact will be partly incorporated in it when the height is increased. The location is at the head of a moderate rapids and an island is made use of to isolate the tail race from the main river channel.

As constructed at present, the development has a 55-ft. normal head with flash boards on the spillway. The ultimate normal head for which the plant is designed is 80 ft. This will give an increase in power of about 75 per cent. The dam is particularly well adapted to the scheme of later raising the pond level. It is a reinforced-concrete structure of the Ambursen type. The increase in height will be accomplished as shown in Fig. 3. When that work is done the present spillway apron slabs will be removed and the edges of the buttresses under them will be stepped, as are now those in the bulkhead and intake section. The enlarged structure will be of such dimensions that the buttresses will require special bracing. For this purpose struts between them, not shown in Fig. 3, will be incorporated in the new work.

From the foregoing it will be noted that with the exception of the spillway apron and walkway slabs all parts of the present dam had to be designed to take the loads which the structure will be subjected to when the pond level is raised.

Details of Design—Both dam and power house are founded on granite ledge of the river bed so that no foundation difficulties were encountered. However as the river banks are earth, abutments were necessary. These are gravity type with cutoff walls extending into the banks in line with the upstream faces of the abutments. The west abutment is considerably the larger as it must protect the bank from erosion of the water passing the spillway. For a flood of 35,000 sec.-ft., the highest on record, the depth on the crest would be about 10 ft. The maximum spillway capacity is 50,000 sec.-ft.

The buttresses of the dam have a normal spacing of 15 ft. on centers. All except for portions of those in the intake section and one just east of the power house subjected to earth pressure, are substantially of plain concrete with rods placed only just above and below each construction joint. These rods are bent up just behind the downstream faces of the buttresses to provide bond bars for the later extension of the buttress and will be uncovered and bent down when the dam is raised. The haunches which carry the deck are also reinforced. At the lowest elevation above the footings the maximum buttress thickness is 26 in., and there is a reduction of 2 in. at the construction joints which are 12 ft. apart. The shoulders thus formed provided bearing supports for forms, in addition to accomplishing the reduction in thickness consistent with reduction in load-carrying requirements as the top of the dam is approached.

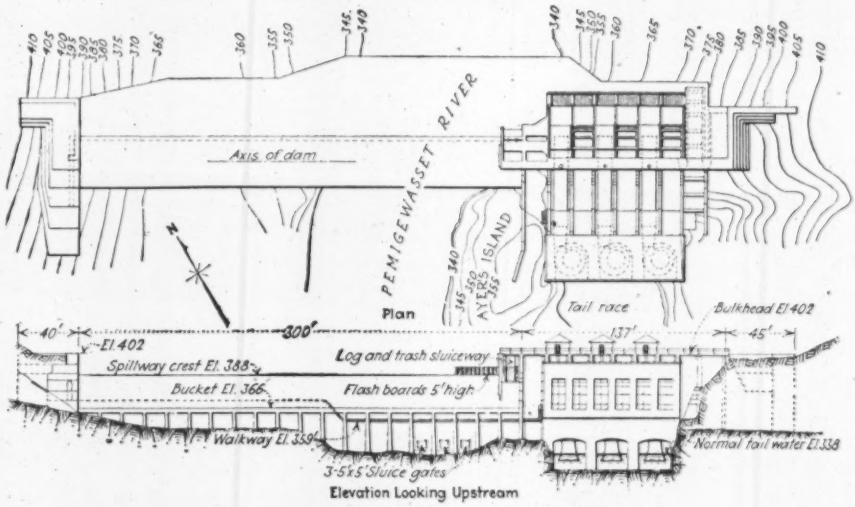


FIG. 1—PLAN AND ELEVATION OF BRISTOL DAM

The inclined deck slabs are reinforced with straight bars which are easily kept in accurate location during construction. As the slabs span only adjacent buttresses they were designed for simple beam action. Expansion is provided for at the haunches upon which the slabs rest by a bitumastic film. The cutoff wall, which is really an extension of the inclined deck, is carried 3 ft. below the surface of good solid rock for the full length of the dam. The spillway apron slab is not supported on haunches, as is the inclined deck, but directly on the downstream edge faces of the buttresses.

It will be noted from the cuts that the spillway bucket is located rather high. This arrangement was considered satisfactory as the discharge over the spillway strikes the rock bed some distance from the buttress footings

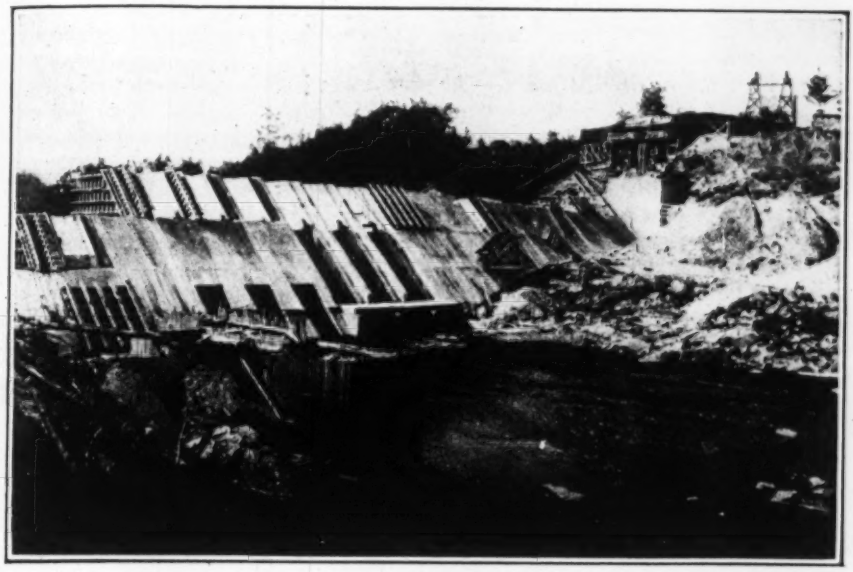


FIG. 2—UPSTREAM SIDE OF DAM DURING CONSTRUCTION
The deck slabs above the closure openings in the center of the dam were the last to be poured in order to provide for abnormal floods during construction. Sluice gate recesses to the left of the closure openings.

and the rock is of a very substantial nature. Furthermore it was desired to have as little investment in the spillway as possible in view of the fact that it must be removed when the height of the dam is increased. A timber apron was considered but estimates of cost indicated that little if any saving would result. Furthermore timber would not be easy to fasten in place.

The intake section of the dam presented a very considerable amount of design work. From the cuts it will be noted that this section involves seven buttresses and horizontal shelf slabs, with vertical back slabs set in between these buttresses and a gap in the inclined deck.

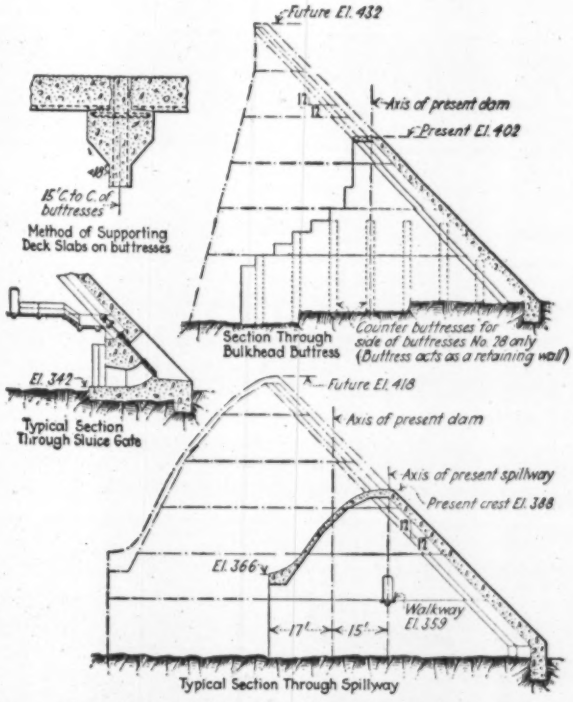

Future El. 432
Axis of present dam
Present El. 402
15' C. to C. of buttresses
Method of Supporting Deck Slabs on buttresses
Section Through Bulkhead Buttress
Counter buttresses for side of buttresses No. 28 only (Buttress acts as a retaining wall)
El. 342
Typical Section Through Sluice Gate
Future El. 418
Axis of present dam
Axis of present spillway
Present crest El. 388
El. 366
Walkway El. 359
17'
15'
Typical Section Through Spillway

FIG. 3—CROSS-SECTIONS OF THE DAM
Outline of future additions to raise crest are shown dotted.

Triangular areas of the facing sides of the two end buttresses of the seven form the ends of the shelf, and consequently will be subjected to water pressure of considerable magnitude in the ultimate development—that equivalent to a 66-ft. head at the top of the horizontal slab. To take care of this pressure the thickness of the two buttresses was increased behind the wetted triangular areas, and reinforcing steel was added, so that in addition to carrying the other loads to which they were subjected they would act as vertical slabs. These two slab sections also were tied together and held in place by tension rods running across the six bays.

The rods were hooked around the reinforcing bars in the end buttresses, and were placed in the horizontal deck slab and vertical back slab and in the struts between the buttresses which are in line with the inclined deck. The rods in the horizontal slabs take the tension caused by the bending moment of the water load on the slabs and their weight, in addition to the tension developed by acting as ties as described above.

The wet portions of the intermediate five buttresses have the water pressure on them equalized by the large rectangular openings through them. However, an unbalanced pressure will exist on that portion of any of the five intermediate buttresses which is between the stop-log grooves and the vertical and inclined deck slabs when stop-logs are in place and the space behind them is unwatered. To take care of that condition the sections of these buttresses between vertical slabs and stop-log grooves are designed to act as cantilevers having their reaction at the vertical slabs. Above the point where the vertical slabs join the inclined slabs, the portions of the buttresses which may have pressure on one side only are designed as slabs themselves and the struts between buttresses prevent failure when the spaces behind stop-logs are unwatered.

In the three bays in which the penstock entrances are located the vertical slabs are much thicker than in the other three bays. They were made so to provide adequate anchorage for the upper ends of the penstocks and to minimize leakage; but thickness of concrete was not alone depended upon, as the penstocks are riveted to the head-gate frames, and the latter are well anchored in the buttresses.

Stresses Used in Design—The specifications for the dam stipulated that compression in concrete buttresses was not to exceed 200 lb. per sq.in. and in deck slabs 500 lb. Reinforcing steel was not stressed over 16,000 lb. per sq.in. For both the present and ultimate structure under maximum estimated flood conditions the computed factor of safety with respect to overturning is well over 4; and the resistance to sliding as represented by the coefficient of friction is 0.6. Both of those values apply not only to the spillway section but throughout the dam. In these computations no uplift was included,

as none was considered to exist in a hollow dam of this type, and the weight of water upon the spillway apron was ignored. Similarly no ice pressure at or below the great crest level was included in the stability calculations as it was considered that ice will slide up the inclined deck and be pushed over the crest without producing an overturning thrust combined with the simultaneous horizontal component of water pressure on the dam which is as great as the overturning thrust from water pressure on the structure at flood times.

For cutoff walls, deck and spillway slabs the concrete mix was 1:2:4 and in abutments and buttresses 1:3:6, except for these portions of the latter which were reinforced to act as vertical slabs, where the mix was 1:2:4.

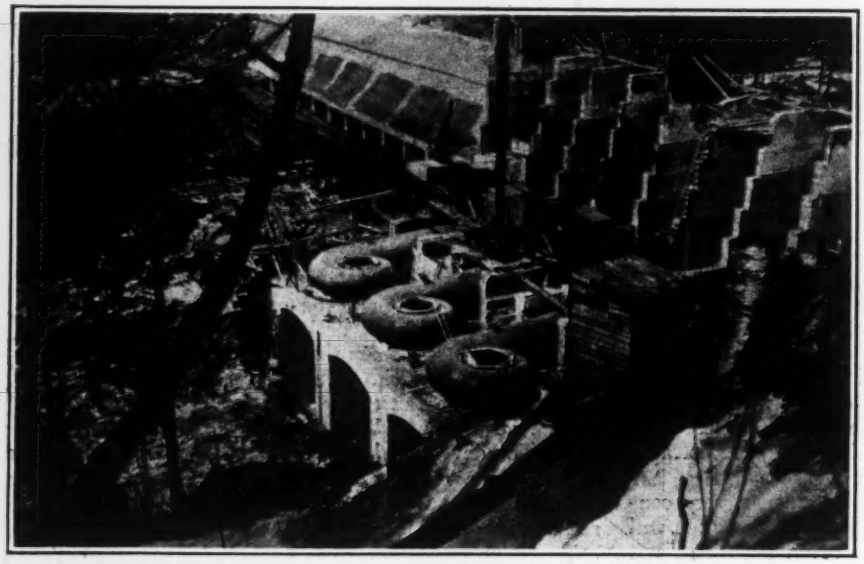


FIG. 4—PARTIALLY COMPLETED DAM AND POWER HOUSE
Buttresses for higher dam built into power house. Completed spillway, upper left center, shows high elevation of spillway bucket.

Flash Boards—In the design of the 5-ft. flash boards on the spillway crest (which are not yet installed) pipe posts are contemplated because for this height they are lighter and more easily handled from a scow or boat than solid soft steel or wrought-iron rods. As pipe posts fail with a sharp kink just above the top edge of the supporting sockets, leaving them otherwise straight, one re-use is planned by having the pipe long enough to turn end for end after the first failure. It is intended to use three sizes of pipe and to divide the crest into three equal sections, in each of which only one size of pipe will be placed, the idea being to have only a third of the flash boards go out at a time during a flood and reduce the amount of water which is released at one time. Post sockets are all placed 3 ft. on centers, boards of one thickness being used between all posts in the three groups of pipe sizes.

Intake—The penstocks are 10 ft. in diameter, of ⅜-in. plate steel reinforced with girth angles. Each has an 18-in. vent pipe at the high point. As previously stated, the upper ends of the penstocks are riveted to the frames of the head gates which are of the caterpillar type, 10x 10 ft., built of structural shapes and plates with wire rope hoists, hand operated, but designed so that motors may be added later. Like the sluice gates, these head gates and hoists are designed for the ultimate load.

A feature of the trash racks is the use of fixed guide bars which form individual channels for interchangeable sections of bars, and which are flush on the raking surface with the removable bars and act as bars themselves. These fixed bars facilitate placing and removing the removable sections. The rack bars were designed for a 15-ft. head differential but the supporting I-beams are good for the full water pressure with racks entirely clogged.

Power House—The power house was initially built and equipped for the ultimate development. It has incorporated in its structure sections of seven buttresses which are portions of extensions that need to be made when the dam is increased in height. These buttress sections were built at the present time in order that the station could

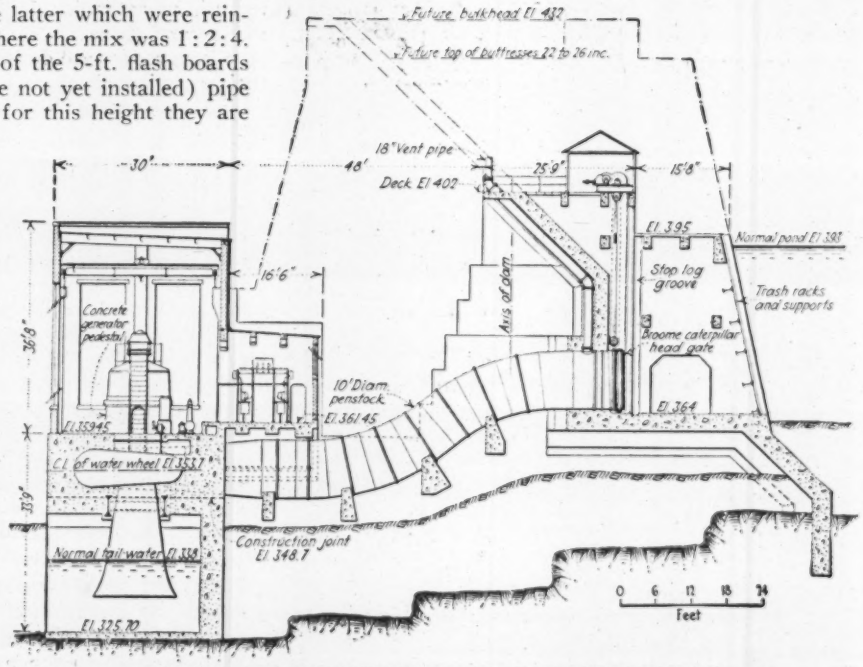


FIG. 5—SECTION THROUGH INTAKE AND POWER HOUSE

be completed in its permanent arrangement as it was so located that only the generator hall will extend beyond the future dam, the switch and service bays being between the buttresses. This procedure will minimize interference with the operation of the plant when the later construction work is undertaken as it will then be confined entirely to the dam except for the replacement of the present runners in the waterwheels with new runners of smaller diameter designed for the 80-ft. head. The curb rings of the turbine settings are especially designed to make this change possible.

Fig. 5 is a section through the substructure of the power house. The two embedded 42-in. plate girders under each unit span the tail-pit and are designed to carry the weights of the generator stator, concrete generator pedestal, speed ring and all attached parts except the scroll case, the revolving generator and waterwheel element, the hydraulic thrust, and the weight of concrete and the station floor live-load between the generator pedestal and half the distance to the horizontal projection of the tail-pit walls. Comparative estimates indicated that the use of the structural steel was cheaper than the usual reinforced-concrete design.

The construction joint at El. 348.7 across the entire substructure was provided in the design to give ample space for the erection of the embedded parts of the waterwheels. The concrete slabs over the tail-pits thus formed were reinforced to carry not only the construction loads but also the permanent loads which were considered to be the weight of the scroll cases filled with water and the weight of concrete to the grades of the top of the scroll cases within the plan area between the generator pedestals and the walls of the tail-pits.

The station floor is designed so that the heaviest part of the machinery may be placed anywhere on it. Over the scroll cases radial reinforcement is used and the scrolls themselves are relieved from superimposed load.

In the design of the power house an effort was made to house the equipment in a structure of minimum space requirements with a minimum concrete yardage in the substructure. The use of generator pedestals which are higher for their diameter than is common was an item in accomplishing this end. The pedestals are of concrete very liberally reinforced. In the top rings the reinforcement is in the form of continuous hoops and in the barrel below a grillwork of steel bars is placed on the inside and outside faces. The vertical bars extend down into the substructure. The loads for which the pedestals were designed were taken to be the sum of the total weight of the generator stationary parts, the weight of the revolving element of the unit, the hydraulic thrust on the bearing at the top of the generator, all increased 50 per cent and acting vertically and applied uniformly around the top; and a torsional force equal to 50 per cent of the total weight of the generator applied horizontally at the top of the pedestal on the foundation bolt circle. It was considered that inclusion of this latter force would provide for the condition of short circuits and other electrical disturbances.

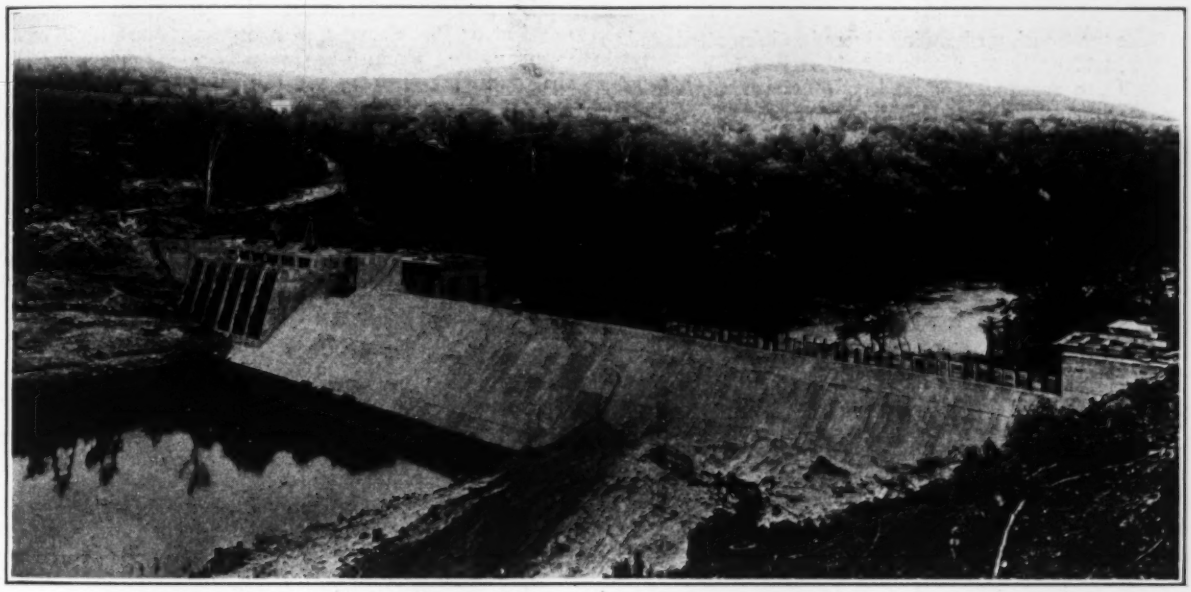


FIG. 6—UPSTREAM SIDE OF DAM, JUST AFTER FINAL CLOSURE (INTAKE TRASH RACKS AT LEFT)

The holding-down bolts for the generators were extended down to the level of the station floor. As a construction detail it was not considered practical nor necessary to have them extend into the substructure.

As has been stated the spaces between buttress extensions were utilized for the switch gear and station services such as store room, repair shop, and toilet room.

In the power house there are three units with generators initially selected for the ultimate development. Each is a 3,500-kva., 2,300-volt, 3-phase, 60-cycle, 257-r.p.m. Westinghouse vertical generator, with direct-connected exciter, driven by an S. Morgan Smith water wheel which under the present head develops 2,500 hp. Only low-tension switching is handled in the building. The generator voltage is stepped up to 33,000 volts for transmission of the energy at an outdoor transformer station on the river bank above the power house.

The dam was designed by the Ambursen Construction Co. of New York, which had the contract for the construction of the entire plant. Both the design of the dam and the construction work were under the supervision of Jackson & Moreland, engineers, of Boston, Mass., who also designed the power house.

Meanderings of Alluvial Rivers Governed by a Fixed Law

Movements and Changes in Amount of Silt Held in Suspension Are Similar on Streams Flowing Through Alluvial Plains

By P. Claxton
P. W. D. Irrigation, Punjab, India

ALLUVIAL rivers subject to flood have similar characteristics the world over. Therefore, the principles which govern them in India will be of interest elsewhere. They have been studied for years on the great rivers of the Punjab, such as the Sutlej, the Chenab and the Indus, and all have been found to depend upon one leading principle which it is the object of this article to emphasize.

The meandering of Indian rivers has been attributed to a law, which, by regulating length, strives to co-ordinate velocity to resistance of banks. However, a river may as readily co-ordinate velocity to resistance by simply widening its bank. Because it does not, but meanders, we must look for an explanation in other causes. The greatest other cause is silt torn from the banks and bed. In the Punjab, action at banks is termed erosion, while over the bed it is spoken of as scour. Silt from scour

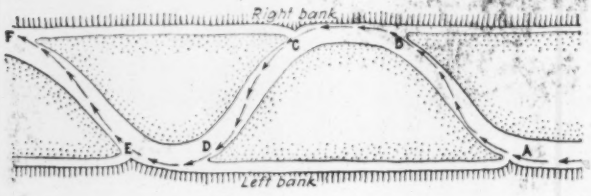


FIG. 1—TYPICAL ALLUVIAL RIVER CHANNEL

enters little into competition in forming rivers, but silt from erosion very largely.

It may be assumed that no alluvial river will flow straight. Sooner or later it will be deflected into a bank, when erosion is started. A great deal of academic interest has seesawed about the movements of silt created by this erosion. Some engineers point to the laboratory experiments which prove cross currents at a bend in a small artificial channel, and argue that the curvature of an eroding bank offers similar conditions and that silt may be, and is, carried over by the river from the eroding outer bank to the inner shelving one. The fact is that the artificial channel is narrow, and reaction around a bend creates a surface slope right across, and thus gives rise to a cross strain by which particles may be transported from the outer side to the inner. On a river where the width is enormous, this reaction does not extend to any appreciable distance from the bank, and its effect is entirely lost. The main flow, on the other hand, is a strong force across which nothing in suspension can pass.

We therefore conclude that the silt of erosion at one bank is not carried to the other. Since silt must sooner or later be deposited we should therefore look for it on the same side upon which we find the erosion. On that side, as the load of silt increases all down the line of erosion, it becomes a strong factor giving us a leading principle. It is this principle which explains the meandering of rivers and their behavior in general.

The general form of a river as it meanders is given in Fig. 1. This form is stereotyped throughout India, indicating that rivers are subject to one principle. In this figure the main stream is shown by arrow heads along the line *A B C D E* while *A D* and *C F* are minor creeks of which it is unnecessary to take notice.

From *A* the main stream crosses to *B*, having deposited its load of silt on its right side on the shoal above. At *B* it is therefore clear. From *B* it begins to erode the bank and the load of silt steadily grows, till at *C* it can carry it no further. It then begins to deposit the silt, which becomes a strong turning force, causing the stream to cross over to the left, the silt eventually forming the island *C D E F*. From *D* to *E* the process is repeated, but this time on the left side of the stream.

Inundation canals, which have no masonry headworks, are dependent entirely on these conditions. A canal at or just above *B* will be well placed as it has a clear offtake. From *B* to *C* it will have a tendency to silt, the conditions growing steadily worse. Below *C* it will

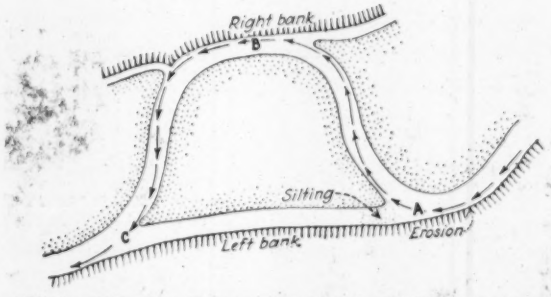


FIG. 2—NATURAL RIVER CHANNEL CLOSED BY SILTING

have shoaling at the offtake. On the other side the conditions are repeated. Thus, the favorable offtakes are *B*, *D* and *F*. These conditions are certain, and for that reason go a long way to prove the correctness of the principle that silt will remain on its own side of erosion.

The writer has proved it in other ways also. For instance, on one occasion a shoal similar to *C D E F* of Fig. 1 gave cause for anxiety, and was brought under observation. It was then found that the shoal came and went and was not stable. This remained a mystery till erosion above, from *B* to *C*, was studied. It was then found that this erosion was alternately severe and light. When it was severe the shoal appeared, and when light the shoal melted away. Erosion and shoaling, in other words, were discovered to synchronize as cause and effect.

Another remarkable instance caused much damage and loss. The main stream, which had been straight along *A C*, Fig. 2, changed into an indirect loop of a creek *A B C*. The reason was found to be severe erosion above *A* on the left bank. This erosion created so heavy a shoal just below *A* that it deflected the main stream into this unnatural channel. No human agency could have accomplished a greater feat, for the river was then discharging over 100,000 sec.-ft.

With these examples it is not difficult to realize why engineers, up against such a river, accept the principle that silt remains on the side of erosion. Perhaps floods sharpen their wits, for a river which runs an even course might pass unnoticed, but in flood it forces itself much more on their attention.

Open-Cut Subway, New York City, Built Under Unusual Conditions

Excavation in Narrow Working Space with Railway Adjoining—Stability of Firm Glacial Drift—Special Bracing for Sheetpiles—Undercrossing of Four-Track Railway

By George Paaswell
Engineer, Corson Construction Corporation, New York City

CONDITIONS somewhat unusual in subway construction were met in building section 6E2 of the 14th St.-Eastern subway in Brooklyn, New York City. This is a two-track section of line lying in a narrow easement between the roadbed of the Long Island R.R. and two cemeteries; about four-fifths of the 5,000-ft. length of section is on curve, and the two tracks are partly on one and partly on two levels. The latter is because at one station the required width of structure for a one-level station exceeded the available right-of-way width. Rather deep excavation and a closely controlled trench width were therefore necessary. By taking advantage of the favorable nature of the soil, the contractor nevertheless was able to do most of the excavation and construction in open, unsheeted trench, and accomplished rapid work at relatively low cost by resorting to economical methods of sheeting and bracing. A special method developed for constructing the undercrossing of the line under the four tracks of the Long Island R.R. also contributed to low cost.

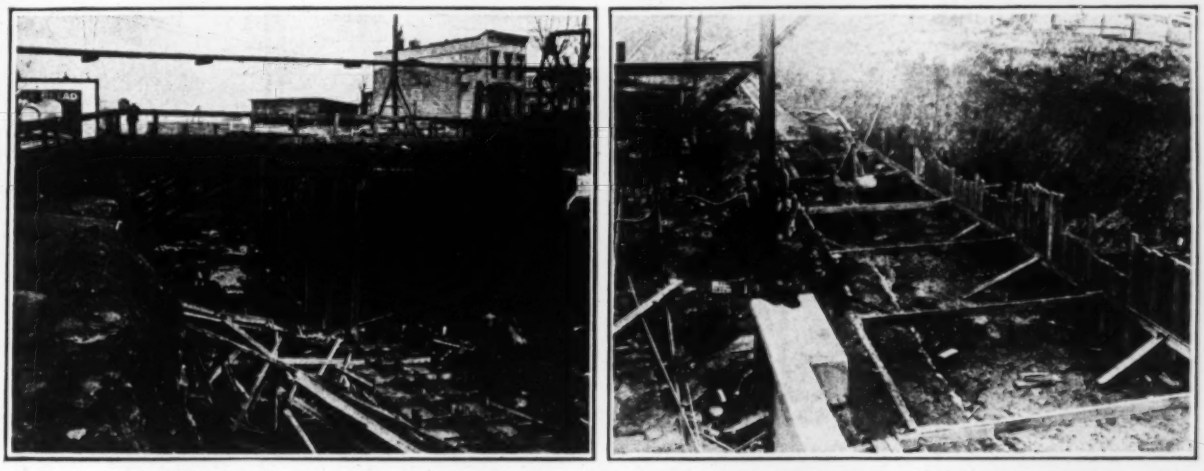


FIG. 1—COMPACT GLACIAL TILL; SIDES OF SUBWAY EXCAVATION STANDING ON STEEP SLOPE
At left, Aberdeen St. crossing, center bench of subway already concreted. At right, view near middle of section, with subgrade ready for concrete.

The subway section in question extends from Cooper and Wyckoff Aves., Queens Borough, to Stewart St. and Bushwick Parkway, Brooklyn. It is to be operated by the Brooklyn Municipal Transit Corporation. The contract was let on Aug. 5, 1926, for $2,500,000, and at the present time it is about 80 per cent complete.

Design of Structure—Extending alongside the Long Island R.R. embankment, much of the structure is in effect a cellular reinforced-concrete retaining wall (see sections in Fig. 2) supporting the railroad embankment on one side and abutting against the lower ground of the cemetery on the other. Part of the length rises above the level of the railroad, which at this point is in tunnel, and extends over the roof of the railroad tunnel. At the north end it connects with a completed section of subway, while the south end rises out of the ground to connect with elevated structure. Of the two stations on the line, one has both tracks at the same level while at the other station the tracks are superimposed. The vertical interweaving of the tracks is further complicated by the requirement that one of the streets crossing the line could not be passed either over or under the two tracks (which here are superimposed) and therefore had to be passed between them, so that the structure at this point includes both subway and elevated viaduct. The adjoining railroad embankment is of maximum height, and excavation subgrade therefore is at maximum depth, 40 ft. below railroad track level.

At first it was assumed that most of the length of line would have to be constructed inside of sheeting, extending to ground level, which would mean a costly method of excavation besides the expense of sheeting and bracing. But at this point of the planning the soil conditions were carefully studied, and it was concluded that much cheaper methods were possible because of the favorable condition of the material.

The soil encountered is a compacted glacial drift, typical Long Island ground-moraine material with occasional beds of sand or pockets of clay with boulders. This material has almost the characteristics of a natural hardpan, and is capable of standing for a long time on practically vertical slope of 20 ft. high or more. The rail-

road embankment, about 15 years old, also was well compacted mixed material, and could be depended upon to have similar stability. The contractor decided that these conditions could be taken advantage of to carry on most of the excavation without sheeting the sides and without flattening the side slopes beyond the range of the right-of-way. This permitted taking out much of the excavation by steam shovel, which meant low cost. The preliminary study indicated that about 70 per cent amount of hand trimming was necessitated where the station platforms on either side extended into the toe of the bank as first taken out.

In fixing the depth of the shovel cut it was assumed that the banks would stand at a slope of 2 on 1. The edge of the slope was not to come nearer the center of the nearest operating track than 12 ft. The outer one of the four railway tracks had been taken over by the Board of Transportation, under contract with the Long

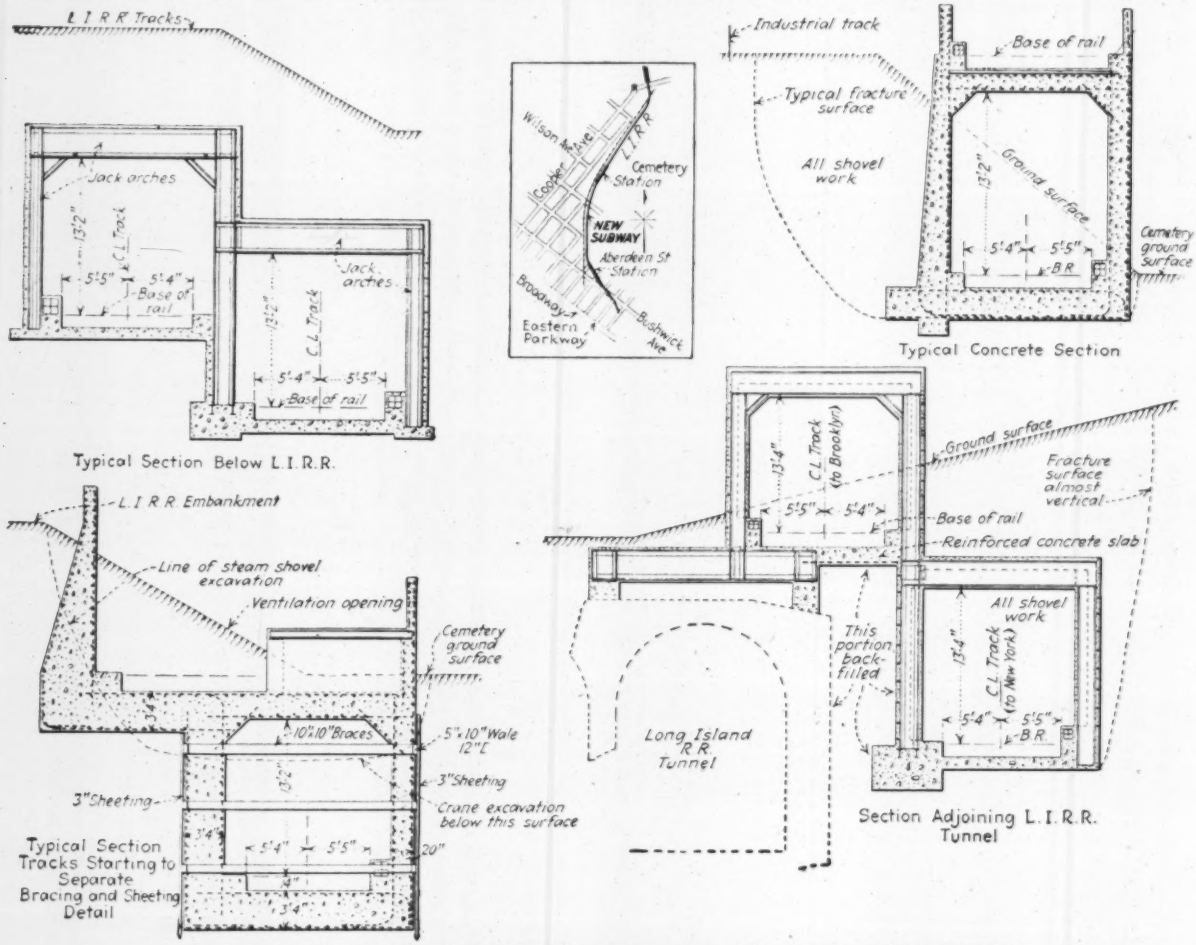


FIG. 2—LOCATION MAP AND TYPICAL SECTIONS OF SUBWAY WORK IN BROOKLYN
Lines of shovel cutting indicate how the stability of the soil was utilized.

of the total excavation could be removed by steam shovel; in actual construction this was reduced to about 60 per cent.

To explain the nature of the construction to be carried out, several cross-sections are given in Fig. 2 in conjunction with a small scale location map of the line. In these sections the original ground surface and the general line of the excavation are shown.

Plan of Excavation—The first lift of excavation was removed by steam shovels, using two 1-yd. shovels. These carried the trench to a depth of 20 to 22 ft. below the railroad track, which meant to subgrade for a distance of 1,200 ft. out of the 5,000. The second lift of excavation was handled by the same shovels equipped with clamshells, working in conjunction with the operations of timbering and sheeting; a gasoline shovel equipped as a crane assisted in this work. A small Island R.R., to reduce the cost of construction and to minimize the hazard to the railroad company. This track was turned over to the contractor. As the edge of the subway neat line was about 25 ft. from the center of the next (or first operating) track, the edge of slope could be allowed to extend 13 ft. from the neat line, and accordingly shovel excavation could have been carried on to a depth of about 25 ft. below the railroad track grade. However, the contractor decided to operate an industrial track along portions of the abandoned railroad track for transporting concrete, and accordingly excavation in unsheeted trench was limited to a depth of about 22 ft. All greater depths were sheeted in the lower portion.

In the execution of the work the assumptions on which this excavation plan was based were fully realized. The cut is at present about eight months old, and during this

period severe weather conditions were experienced, including many periods of alternate freezing and thawing; yet the banks at no point broke beyond the assumed limit. It has been possible to operate the industrial track at all times, there has been no settlement whatever in any of the operating tracks of the railroad, and service has proceeded without interruption.

Sheeting and Timbering—The methods of sheeting and timbering of the cut were studied to adapt them to the method of pouring the concrete structure. It was expected that lateral pressures would be small, and that accordingly the banks could be held safely by light horizontal walers. In general, 3-in. sheeting was used, although at the beginning of the work a portion was sheeted with 4-in. material. At most points the sheeting formed the back form for the concrete. As heavy reinforcement was required (1¼-in. bars) the inside faces of the walers were so set that the reinforcement could be pinned to them. The horizontal members were made up of a 12-in. channel inclosing a 4x10-in. timber, held by transverse 10x10 braces 10 ft. on centers (Fig. 3). The braces were progressively removed as the structure was poured.

It was found that practically all the detectable loading upon the sheeting was that induced by the backfill placed behind it. It was interesting to note that the vibrations of the passing heavy freight trains had no noticeable

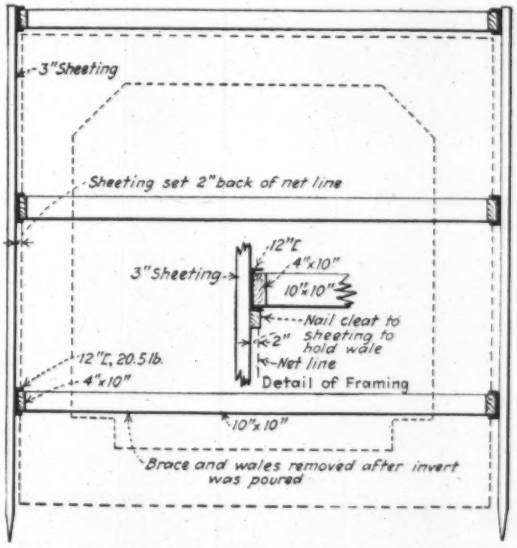


FIG. 3—TYPICAL SHEETING WITH THIN WALERS

effect on the stability of the banks, which seems to justify the assumption that no impact factor need be added to loads on earth-sustaining structures, Moreover, the lateral pressure at no time exceeded one-tenth of the entire vertical load coming within the slip surface of 1 vertical on ½ horizontal.

Railroad Undercrossings—Two particular pieces of construction of special difficulty were involved in this subway section, both of them being crossings under the Long Island R.R., where, of course, no interruption to operation could be permitted. The entrance to the Wilson Ave. station is made by a passageway about 23 ft. wide, under the railroad embankment. Farther north, at Cooper Ave., the subway itself passes under the railroad tracks.

At Wilson Ave. undercrossing the following method was adopted: For temporary support of the tracks, a 26-in. 160-lb. girder was set alongside each rail, just outside the ends of the ties, and the lower flanges of these girders caught the ends of 6x12-in. timber ties set vertical inserted between the existing ties of the track. The girders were chosen long enough to lap 7 or 8 ft. over into the ground back of the future sidewall of the undercrossing, and two sets of sills were bedded under the girders here to distribute the loads that would come

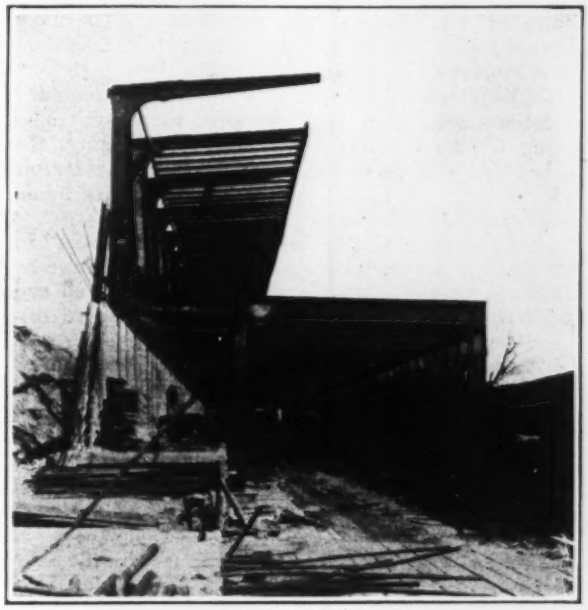


FIG. 4—DOUBLEDECK STATION TO SUIT NARROW RIGHT-OF-WAY

on them. This construction furnished a substantial cradle to carry the railroad tracks. Heavy 125-ton freight locomotives are operated over these tracks.

When the cradles thus had been placed, a center heading about 7 ft. deep was pushed through, and temporary posts were set in this heading under the beams. Then the sides were excavated down to the same level, and temporary posts were set along the neat lines of the undercrossing. Then a lower center drift was pushed through, and the short center posts were replaced by full length posts to subgrade, after which the same thing was done along the side, excavating, setting full length posts in front of the short posts, and simultaneously placing horizontal sheeting back of the full length posts. When the sides were thus supported, the center posts were removed. The full width and height of the undercrossing were thus left unobstructed, and the contractor used the passageway for trucking between subway cut and street, during a number of months, before setting forms and concreting the sidewall and roof of the undercrossing.

A more elaborate method, using the same track-cradle principle, was used to construct the Cooper Ave. undercrossing, where, on account of the width of excavation and the skew of the crossing, it was particularly necessary to arrange the construction methods for complete security. The writer hopes to describe this piece of work separately later.

Concreting—For placing the 40,000 yd. of concrete in the job, it was decided to use a central mixing plant.

The only available location was at the third-point of the section, which, while not the most economical for transportation, provided ample room for both the mixing plant and the material storage. A 1-yd. elevated mixer at this point was arranged so that it could chute concrete to separate loading hoppers arranged to supply motor trucks for hauling to one end of the work by way of the street, and two industrial tracks extending respectively along the abandoned railroad track (as already mentioned) and along the roof of the subway (over the concrete forms or over the steel framework, according to conditions). On the industrial tracks, 1-yd. cars were hauled by tractors. A special type of body was mounted on 5-ton trucks with back dumpers to permit rapid placing of the concrete. For winter concreting, the batcher bins were lined with steam coils, and a reservoir tank of water was heated by live steam, supplied by an oil-burning 25-hp. boiler.

After the invert and the lower parts of the walls had been poured, the remainder of the structure (where of reinforced concrete) was formed by traveling wall and roof forms. In one part of the work a standard collapsible steel form 30 ft. long was used. On the rest, two 20-ft. sections of collapsible wood steel-faced traveling forms designed by Joseph Meltzer, persident of the contracting company, was used. Except in cold weather, the forms could be poured, stripped, moved and set up every 30 hr. The fact that the subway structure is variable both in width and in height presented unusual difficulties in the design and operation of the forms.

In the structural steel section of subway, the arches between bents were formed with the usual collapsible steel arch forms, which were supported on an unusually heavy traveler, designed to carry the full weight of the concrete, since most of the steel in this section is entirely incased.

The entire work is under the supervision of the Board of Transportation, with Robert Ridgway as chief engineer, Col. J. R. Slattery as deputy chief engineer, and J. O. Shipman as division engineer. The work is under the immediate supervision of A. Ludholz, assistant division engineer, and B. Houghtaling, section engineer. The contractor is the Corson Construction Corporation.

Special acknowledgment should be made of the courtesy and co-operation of the Long Island R.R. officials. The contractors are especially indebted to F. Auryansen, bridge engineer of that company, for valuable suggestions as to the design and construction of the temporary structures supporting the railroad tracks.

Georgia Has 90 Certified Water Supplies

Of 242 public water supplies in Georgia at the close of 1926, 89 were certified as safe, 90 were not certified either because of insanitary conditions, high bacterial count or failure to submit sufficient samples of water for examination, and 63 sent no samples. To get on the certified list, says the sanitary engineering division of the State Board of Health in its annual report for 1926, the municipality must keep its water-works in perfect shape and submit monthly samples to the laboratory, and the samples must pass the test. Of the 242 water-works in Georgia at the close of 1926, the source of supply was deep wells for 154 cities, filtered stream water for 47 and spring for 30 cities. There were chlorination plants at 109 works in 1926. Dr. T. F. Abercrombie is commissioner of health of Georgia and H. C. Woodfall is director of the division of sanitary engineering.

Long Concrete Bowstring Bridge Erected in France

Design and Construction Details of a Girder Span 286½ Ft. Long Recently Completed at Outskirts of Paris

By W. L. Scott

Chief Engineer, Considère Constructions, Ltd., London, England

WHAT is thought to be the longest concrete bowstring girder bridge in the world has recently been completed at Bagneux, near Paris. The bridge follows in its general treatment the 180-ft. span at Nantes (France) described in *Engineering News-Record*, Dec. 31, 1923, p. 916. The clear span is 286 ft. 6 in.

Of the various types of concrete bridges, the true bowstring is probably that requiring the closest technical study. Secondary stresses are, in structures of this type and size, far more important than the stresses directly produced by the vertical loading. In the ordinary concrete arch bridge the secondary effects comprise deformations produced by elastic arch shortening, shrinkage of concrete, fall in temperature and, in some cases, displacement of abutment foundations. These are cumulative in effect.

In the bowstring girder, to these effects on the arch members must be added the relatively important displacement due to the elastic tension of the ties. The stresses in the arch ribs, referred to above, result from the bending induced by the shortening effects upon the one hand, and by the enforced increase in span, caused by the stretch in the ties, on the other.

A further result of the shortening of the arch ribs and

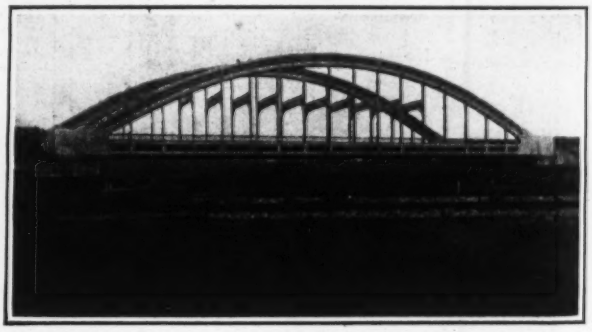


FIG. 1—COMPLETED BOWSTRING GIRDER SPAN OF REINFORCED CONCRETE

extension of the ties is the distortion produced in the vertical hangers, especially those of relatively short length. For this reason, the inertia of the suspenders is kept as small as practicable in the longitudinal direction of the bridge. An added advantage is that the ribs themselves are free to deform under load without undue restraint from this source. Reference to Fig. 2, which gives a view of this bridge before completion, will show the extreme relative thinness of the vertical members.

The economical rise to span ratio for this class of girder is 1:6, the rise actually being 49 ft. The ribs are treated as arches permanently hinged at the springings. They are of H-section with the upper and lower flanges spirally reinforced. The width of the flanges is 31 in. and the total constant depth of the ribs 94 in. In designing these ribs, the stiffness of the ties acting as

girders simply supported at their ends must be considered if the inertia of the latter members is such as to resist appreciably the bending moments caused by the vertical loading.

The proportion of the total bending moment taken by the curved rib at any section is $\frac{M}{Ir + It} \times Ir$

where M = bending moments at considered section, Ir = moment of inertia of rib at considered section, and It = moment of inertia (of the reinforcement only) at considered section. As will be seen, this formula presumes the length of the suspenders to be unalterable during such bending.

The necessity of carefully investigating the effects of wind pressure is obvious when the height of the ribs above ground level at mid-span is appreciated, viz., 71 ft. Horizontal wind bracing has been introduced between the suspenders over the central portion of the span. By means of this framing, the wind pressure is transmitted to the deck platform, which is designed to resist the wind force as a horizontal girder. The total horizontal force produced by the wind acting simultaneously upon both girders is calculated as follows:

Total horizontal wind pressure on deck platform =

$$pb\left(2 - \frac{b}{a}\right)$$

where p = assumed unit wind pressure, b = net surface area of one girder and a = total area enclosed by the underside of the deck construction and the top of the curved rib. This formula presumes a reduction of pressure upon the leeward girder, justified in the case of most bowstring girder bridges met with in practice.

A point of considerable interest is the method of supports adopted. At the left end (Fig. 2) the two main girders rest directly upon the supporting columns, being fixed in position laterally, but free to rotate in the direction of the span to the required extent. At the right end the entire weight is carried upon two concrete rocker bearings placed under the girder ends. These bearings are rectangular in shape and heavily reinforced by double steel spirals interlocked. They are concealed within the fluted columns shown in the illustration, the upper portion of the latter being hollow. The rocker bearings are 71 in. long, 39 in. wide and 79 in. high, and are inclined slightly toward the bridge. The maximum calculated load coming on each of these is 700 (long) tons. Transverse expansion joints have been introduced at the supports, separating the bridge from the approaches.

The roadway slab and footpaths are supported upon transverse deck beams which in turn are carried by the tiebeams situated directly beneath the parapets. The width of the bridge is 32 ft. 10 in. which is suitable to this type of bridge, and enables the specified clear space to be provided under the bridge. The foundations consist of four circular mass concrete columns, 9 ft. 3 in. in diameter, carried down 65 ft. below ground level, to which depth it was necessary to go on account of old quarry workings.

This bridge was designed throughout with only the precise quantities of materials shown to be required by the calculations. A careful inspection of the bridge, at which the writer was present, failed to disclose any defects of even a minor kind, which can justly be held to disprove the contention that concrete structures are susceptible of precise design.

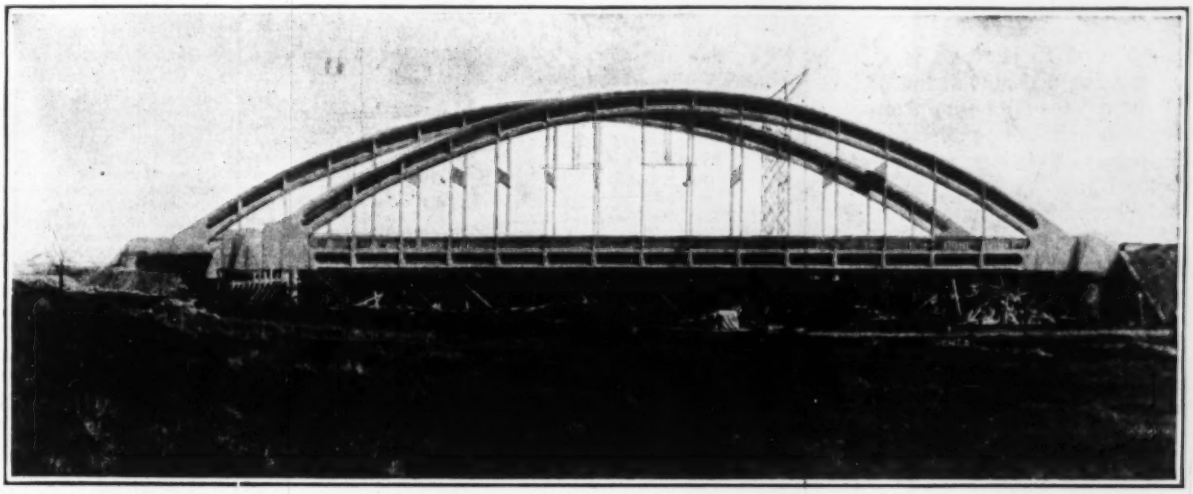


FIG. 2—VIEW OF SPAN, NEAR PARIS, DURING CONSTRUCTION

Floods in Many Countries

Flood news recently at hand includes India, Australia and England. In India, large areas of cotton-growing lands have been flooded by heavy rains, with extensive damage to the crop, while overflow of a reservoir in the province of Baroda is reported as causing the destruction of a dam with disastrous results to villages in the valley below. In North Queensland, abnormal rains continuing for several days resulted in destructive floods on a stretch of some 300 miles. The Burdekin River is said to have risen nearly 80 ft. in one place, or within a few feet of a railroad bridge whose rails are 84 ft. above normal water level. At a low-level trestle ½ mile long, crossing this river near its mouth, the water was 23 ft. deep over the rails. Traffic was suspended for one or two weeks at different points owing to submergence and destruction of the lines. Several lives were lost. In England, early in July, heavy storms caused much damage to the railways, including washouts of tracks, slips in cuts and fills, and flooding of tunnels, with much delay and interruption to rail traffic.

The Snow Report on the Wanaque Aqueduct Controversy

An Editorial Summary and Interpretation

THE decision made two or three months ago by the North Jersey District Water Supply Commission to substitute steel pipe for the concrete portion of the Wanaque aqueduct, thus changing the plan recommended by their own engineers and adopted by the commission in 1924, is supported by F. Herbert Snow, Harrisburg, Pa., in the report summarized on p. 239 of *Engineering News-Record* last week. The report also upholds Col. George A. Johnson, New York City, in his support of the change desired by the commission, in his recommendation of twin "smooth-bore" pressure pipe lines and in most of his accessory recommendations and contentions in their support. As regards relative costs, one of the main points in controversy, Mr. Snow does not support Colonel Johnson's largely increased estimate of the cost of the Pratt-Sherrerd plan, including the Johnson substitution of 15 per cent in place of 10 as the cost of engineering and administration. In estimating the cost of the enlarged Johnson-plan pipe lines Mr. Snow uses Johnson unit costs except for steel pipe in place. This he puts at $125 per ton, instead of the $150 used by Colonel Johnson in his various estimates and by Pratt and Sherrerd in their estimates for the grade aqueduct. This change greatly reduces the Snow estimate.

The major part of Mr. Snow's report of about a hundred pages consists of material quoted verbatim or summarized from the controversal reports of Colonel Johnson and Messrs. Pratt and Sherrerd (abstracted in *Engineering News-Record,* June 30, 1927, p. 1062) and of a 16-p. letter or special report to Mr. Snow from Robert E. Horton, consulting engineer, Albany, N. Y., dealing chiefly with the value *n* for "smooth-bore" steel pipe and briefly with the proper allowance for evaporation from water surfaces. To make the significance of Mr. Snow's report more readily understandable in brief space, without reference either to his extracts from the earlier reports or to the reports themselves, interpretative comment is included with the following summary of Mr. Snow's findings.

Besides upholding Colonel Johnson's arguments for twin "smooth-bore" pressure pipe lines Mr. Snow supports the Johnson argument for omitting the aerator, as such, and his claims that the watershed and reservoir will provide a dependable safe yield of but 85 m.g.d., instead of the 100 m.g.d. called for by the contract and claimed by Pratt and Sherrerd. Mr. Snow's tabular comparison of various other estimates of watershed yield is reprinted here as Table I, with editorial comment appended. Mr. Snow does not support Colonel Johnson in his claims that the aqueduct need have a capacity, in its various sections, of but 135 per cent of the safe yield of the watershed and reservoir instead of the 150 per cent called for in the contract. Instead, Mr. Snow elaborates on Colonel Johnson's argument in favor of substituting all-pressure for a part-gravity aqueduct and for eliminating the aerator at the storage reservoir because all the reservoir head should be made available. Utilization of all this head, Mr. Snow urges, will make possible the delivery for "public consumption" of flood flows of the Wanaque "otherwise wasted." To the same end Mr. Snow supports the enlargement of Mr. Johnson's twin pipe lines from 72 to 74 in. at the upper end, from 60 to 72 in. further down, and the provision of two 72-in. pipe lines instead of Colonel Johnson's original single 72-in. the remainder of the distance. Mr. Snow suggests that one of the two pipes in the lower reach might perhaps be omitted at the start.

This enlargement of the twin pipes to 74 in. as far down as the Paterson take-off would make it possible, Mr. Snow urges, to carry 180 m.g.d. that far instead of the 150 m.g.d. called for by the contract and the 135 m.g.d. which Colonel Johnson contended would provide an ample factor of safety. To make use of the extra delivery head and capacity, Mr. Snow introduces a plan not contemplated in the contract nor included in Colonel Johnson's report nor advocated by the contracting municipalities but which Colonel Johnson may have conceived later; that is, give Paterson, Passaic and Clifton, the three northerly contracting municipalities, the benefit of the greater head and delivery capacity resulting from the abandonment of the original Pratt-Sherrerd plan. One suggested means of getting this benefit is to deliver water into two small existing reservoirs in Paterson, also to build a pumping station to deliver water into the Great Notch reservoir of the Passaic Consolidated Water Co., now filled by pumping Passaic River water from the filtration plant at Little Falls, and used as an equalizing reservoir for a number of communities, some of which are and some not in the North Jersey Water District. Both suggestions introduce economic, financial and hydraulic factors not entering into the contract between the district and the contracting municipalities.

To utilize extra head and delivery capacity south of the Paterson offtake presents a problem that Mr. Snow states but says he did not have time to solve: How to get more than the contract quantity of 150 m.g.d through the Great Notch tunnel bottle neck already built as a grade tunnel to work under relatively slight pressure

TABLE I—SEVEN ESTIMATES OF WANAQUE WATERSHED YIELDS

Authority	M.G.D.	*Remarks*
Pratt & Sherrerd	100.00	With flashboards
Pratt & Sherrerd	84.54	With flashboards, arithmetical method
Pratt & Sherrerd	81.54	Without flashboards, arithmetical method
Pratt & Sherrerd	90.04	Probability method
Freeman	86.34	In terms comparable with Johnson
Johnson	85.00	Range 82 to 88
Snow	84.40	General rule
Av. of 6 estimates	85.47	

EDITOR'S NOTES—Calculation shows that of the seven sets of figures presented the one thrown out by Mr. Snow in making his average was the highest one, 100 m.g.d. The average of the six estimates other than that of Mr. Snow is 87.9 and of the five estimates other than those of Snow and Johnson, 88.5 m.g.d.

Mr. Snow states that the foregoing yields are based on an allowance of "4 m.g.d. for the value of flashboards, 7.46 m.g.d. for evaporation, 10 m.g.d. for wastage to the river."

There is reason to believe that evaporation (of an amount that cannot be stated) was allowed for by Pratt and Sherrerd in their calculations (resulting in the first four items) and it seems unlikely that so seasoned an engineer as John R. Freeman would have overlooked it—in which case evaporation has been deducted twice in the first five items.

In the special report to Mr. Snow by R. E. Horton the latter answers a query from Mr. Snow as to whether Mr. Snow was correct in using the FitzGerald evaporation factor of 43.63 in. per year. Mr. Horton cited figures by his own formula showing 36.26 in., or 15 per cent less, which would not greatly affect Mr. Snow's result. Mr. Horton went on to advise that land and water yield be computed separately, but did not state the significance of the remark as applied to the Wanaque computations. Study of Mr. Snow's report appears to show that, from the official gagings of runoff, including the water area of Greenwood and Sterling Lakes, he deducted water-surface evaporation, already taken care of by nature.

It should also be noted that Messrs. Johnson and Snow put an interpretation on the state permit for diverting water from the Wanaque that makes the wastage downstream 10 m.g.d., whereas Messrs. Pratt & Sherrerd interpret the permit to require only 7.5 m.g.d. Mr. Snow quotes the permit stipulation but does not explain why he and Colonel Johnson took the higher of the two possible figures. Apparently Messrs. Pratt and Sherrerd used the lower figure because a conditional clause in the permit might be interpreted as lessening the maximum wastage by 2.5 m.g.d. in case water stored in Greenwood Lake were drawn to the aqueduct, a possibility assumed by them in certain calculations for flashboards on the dam at Greenwood Lake.

TABLE II—SNOW ESTIMATE FOR ENLARGED JOHNSON PIPE LINES

Sta. 17 to Great Notch tunnel		
Pipe lines	$4,654,334	
Special structures	700,000	
Contingencies	50,000	
	$5,404,334	
Engineering and administration, 10%	540,433	
	$5,944,767	
Land	359,227	$6,303.994
Great Notch Tunnel to Belleville		
Pipe lines	$1,113,680	
Special structures	170,000	
	$1,283,650	
Engineering and administration	128,365	
	$1,412,015	
Land	100,000	$1,512,015
Grand total		$7,816,009

EDITOR'S NOTE—Had the unit price of $150 a ton for pipe in place been used, as in the original Johnson pressure pipe estimate and the Pratt-Sherrerd estimate for pressure pipe where used in their grade aqueduct, the total cost for pipe in place would have been $1,153,595 larger than in the table and for engineering and administration $115,359 larger, thus adding $1,268,954 to the Snow estimate and making the total $9,084,963 instead of $7,816,009.

To compare the Snow estimate just altered to put pipe back to $125 a ton with the Pratt estimate of June 15, 1927 (see our Table III), land cost allowances totaling $459,227 have to be deducted from the Snow estimate (because land for the aqueduct alone is not given in the Pratt estimate) and 10 per cent has to be added to the Pratt estimate for administration and engineering (also not separately given in the Pratt estimate). These adjustments make the Snow total $8,575,963 and the Pratt total $6,283,000, land excluded in each case and Snow unit pipe costs raised to $150. Mr. Snow supports Colonel Johnson's claim that land costs under the Johnson plan would cost less than under the Pratt plan (see *Engineering News-Record*, June 30, 1927, p. 1062).

only. Passing over this unsolved problem, Mr. Snow suggests that the extra head afforded by omitting the aerator and building pressure pipe lines, in addition to the benefits made possible above the tunnel, would reduce pumping in the higher portions of the water district below the tunnel, and make available the Wanaque flood waters that would otherwise be wasted. Realization by Mr. Snow that storage not now available would be required to utilize the flood waters below the Great Notch tunnel appears from his suggestion that if only the Wanaque tunnel were larger and built to withstand pressure the water commission "could build a storage reservoir south of the tunnel, floating it, so to speak, on the aqueduct." Mr. Snow does not go into the hydraulic, topographic and financial practicability of building a reservoir south of the tunnel on pressure lines designed and operated to conserve head. Literally, if that were possible, as well as figuratively, it might have to float on the aqueduct. Nor in stating that the proposed changes from the original Pratt-Sherrerd plan including the enlargement of the pressure conduits originally proposed by Johnson, need have no effect upon contract capacities and costs, does he seem to have taken into account all the factors involved, particularly not the enhanced advantages he claims for some but not all of the contracting municipalities.

TABLE III—REVISED COST ESTIMATE OF WANAQUE PROJECT
Prepared by Arthur H. Pratt, chief engineer; dated June 15, 1927

	Cost to April 30, 1927	Estimated to Complete	Estimated Total
Construction Cost (Design of 1924)			
Wanaque reservoir	$6,632,000	$1,919,000	$8,551,000
Wanaque aqueduct	1,263,000	5,712,000	6,975,000
Total as per 1924 design	$7,895,000	$7,631,000	*$15,526,000
Construction Cost to additions to 1924 design			
Landscape treatment	.....	$275,000	$275,000
Wanaque dam	.....	200,000	200,000
Additional grubbing	.....	.....	.....
Damage claim settlements	$100,000	.....	100,000
Total construction cost			$16,101,000
Real estate	$2,737,000	$1,022,000	$3,759,000
Water rights	12,000	988,000	1,000,000
Administration, legal and engineering	1,794,000	974,000	2,768,000
Total estimated cost	$12,538,000	$11,090,000	$23,628,000
Credits			
Bank interest	$176,000	$124,000	$300,000
Miscellaneous	95,000	5,000	100,000
	$271,000	$129,000	$400,000
Total estimated net cost			$23,228,000

* 1924 estimate, $15,220,000.

Editorial comments which are found appended to Table II point out various matters that should be considered in weighing the various cost figures, particularly the large decrease in the estimated cost of the enlarged steel pipe lines due to the use of $125 in place of $150 a ton for steel pipe in place, whereas in the previous controversial reports $150 was used on both sides.

Curiously, Mr. Snow, although saying that he accepted Mr. Pratt's estimates, characterized as probably too small for comparison with the estimate for the enlarged Johnson pipes, went back to Mr. Pratt's cost estimates in the water commission report for 1924-25, made up before the size and material of portions of the aqueduct had been fully determined, and deducted from the $9,000,000 total there used the then estimate of $1,290,000 for tunnel service built, the actual cost of which is given in a table two pages further on in Mr. Snow's report (our Table III) together with Mr. Pratt's estimate of June 15, 1927, based on definite materials and sizes for pressure portions of the Pratt-Sherrerd aqueduct plan. The table

As to the controversy over the carrying capacity of the "smooth-bore" pressure steel pipe lines, Mr. Snow presents no arguments himself, but relies on the report by Mr. Horton, already mentioned. Mr. Horton supports the figure, $n = 0.013$ for "smooth" pipe advanced in a general discussion in *Engineering News*, Feb. 24, 1916, p. 373, but as regards the "smooth-bore" pipe with circumferential rivets proposed for the Wanaque aqueduct he concludes, assuming the pipe kept in good condition by periodic cleaning, n would be between 0.013 and 0.014—just where not stated. Mr. Snow takes the lower figure, thus endorsing Colonel Johnson's assumption of $n = 0.013$, but to what extent Mr. Horton's higher figure influenced him in endorsing an enlargement of the original Johnson pipe lines does not appear.

On the greater safety and other advantages of duplicate as against single conduit lines, Mr. Snow merely quotes a small part of what Colonel Johnson said on the subject in his report.

In supporting Colonel Johnson's argument for changing the aerator at the Wanaque dam into a fountain for landscape effect, fed by water wasted downstream, Mr. Snow elaborates Colonel Johnson's argument on the value of conserving head and on the lack of need for aeration. In urging that aeration is not needed and that filtration will probably be the ultimate resort, Mr. Snow overlooks the fact that while a filter plant on a gravity aqueduct would be a simple matter, difficulties might be found in combining it with pressure conduits designed particularly to conserve head. In quoting R. S. Weston on the relative quality of the Wanaque and Pequannock waters, Mr. Snow overlooks the fact that, as cited by him, the terms of reference to Mr. Weston assumed aeration for the Wanaque supply. Whether Mr. Weston advised for or against aeration or merely assumed it would be used Mr. Snow's report does not state.

Cost estimates for the enlarged Johnson pipe lines are given in our Table II while in Table III, prepared by Mr. Pratt on June 15 to show actual expenditures on the Wanaque project—both reservoir and aqueduct—to April 15, corresponding estimated expenditures to complete the work, and a combination of the two, are given.

mentioned gives figures from which Mr. Pratt's estimate for the uncompleted portion of the aqueduct, without land, might have been easily computed for comparison with Mr. Snow's estimate of the enlarged Johnson project (see second note to Table II).

The foregoing interpretative abstract of the Snow report illustrates some of the uncertainties still existing as to the main facts in the controversy, especially the effect of the proposed substitute plan on capacity and cost and the reaction of both upon the contracting municipalities. Further discussion of the subject may be found in our editorial columns, p. 251.

Laying Out Irrigated Farm Units by Topography

Rectangular Subdivision System Abandoned in Laying Out Kittitas Project—Features of New Plan

By George C. Kreutzer
Direction of Reclamation Economics, U. S. Bureau of Reclamation, Washington, D. C.

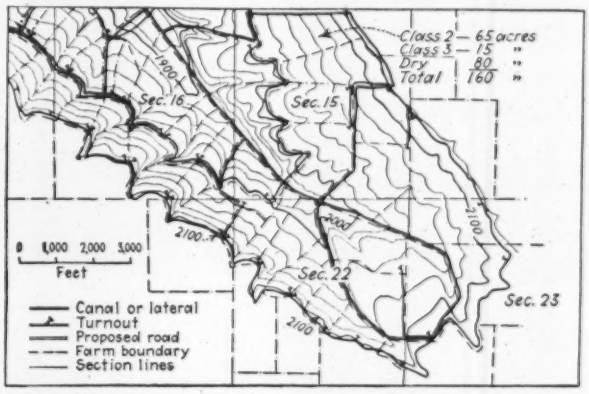
A NEW method of land subdivision into farms is being applied in the development of the Kittitas district, a new division of the Yakima irrigation project in eastern Washington. When completed the Kittitas division will embrace 70,000 acres of irrigable land, of which about one-half was previously partially irrigated from creek rights, while the other half is dry land, for the most part covered with sagebrush. The soil is good, and favors the production of high-priced crops.

The extreme eastern portion of the division is entirely undeveloped and includes what is known as Badger Pocket, comprising about 20,000 acres of land. The federal government, the state and the Northern Pacific Railway Co. own collectively about 50 per cent of this area. The remainder is privately owned, largely by non-residents. This undeveloped area is the one on which the new farm-layout system is being used.

Plans are being worked out so that the boundaries of farms will be made to conform to the natural topographic features of the land in its undeveloped state. The size of farms will vary in accordance with the character of the soil and its adaptability to grow certain crops. Farms suited by air drainage and other favoring conditions to produce fruit will vary from 10 to 20 acres; those of more even topography, without air drainage, adapted to general crops like alfalfa and grain, will vary from 40 to 120 acres.

Heretofore the subdivision of land on projects was based on the public land survey, and was a simple checkerboard subdivision. Sections were divided into 160-acre tracts, and these further into 80, 40 and 20-acre tracts to meet the requirements of settlers. Where the land was generally smooth and of even slope free from depressions, ridges or other natural barriers to the flowage of water in irrigation, this plan of subdivision was satisfactory and is still regarded as good practice. But on many irrigation enterprises the rectangular system made farms composed of depressions and ridges, which required the construction of costly fills or siphons to supply water to the areas thus separated. Other small areas were above the canal or lateral. Roads followed section and half section lines regardless of hills and valleys.

The roads at Badger Pocket will approximately follow contours, ridges or depressions, thus giving even grades. The subdivisional lines of farms will follow roads to provide ingress and egress and will fit in as far as practicable with the location of laterals for irrigation and the center lines of depressions. This will make the farms irregular in shape, but not more so than the separate fields of farms laid out on the rectangular system. It will eliminate many occupation bridges, and one outlet from the



TOPOGRAPHIC LAYOUT OF FARM UNITS, KITTITAS DIVISION OF YAKIMA PROJECT

canal or lateral will supply water to the whole farm. This will add to the convenience in irrigation and cultivation and save in the cost of irrigation structures. Where valley lines form the farm boundaries, it will largely do away with the difficulty of the waste water from one farm flooding another.

The plan herewith shows part of the subdivision of Badger Pocket. The system here applied has the following advantageous features:

1. All small areas of land with surfaces in the same plane are included in the same farm.
2. Construction by farmers of costly fills or pipe lines to convey water across depressions to small areas of land is made unnecessary.
3. Fewer bridges are required because farms are not cut up with laterals or drains.
4. Roads have more uniform grades.
5. One outlet furnishes water to each farm, saving in cost of structures and adding to the convenience of irrigation.
6. Flooding by waste water or breaks in farm ditches is minimized.
7. Better facilities are provided for drainage outlets for farms.
8. Cultivation is made more convenient, because small irregular areas will not be cut off by ditches or natural barriers to irrigation.

As a result of disregarding legal subdivision lines, a large number of the proposed farms include land held at present by two or more owners. In order to carry this plan of subdivision into effect, it will be necessary for the present owners to exchange land. The contract between the Kittitas Reclamation District and the United States provides that all land must be sold at a price fixed by independent appraisal. The appraisal has been completed and approved. These values will form the bases of the exchanges. The landowners have shown a willingness to co-operate and are at present negotiating through committees to solve the matter of making exchanges. Carrying out the remainder of the plan is only a question of putting into effect the knowledge and experience gained on older projects.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

A Notable Bridge Monograph

THE BRIDGE OVER THE DELAWARE RIVER Connecting Philadelphia, Pa., and Camden, N. J.: Final Report of the Board of Engineers to the Delaware River Bridge Joint Commission of the States of Pennsylvania and New Jersey. Camden, N. J.: Delaware River Bridge Joint Commission. Cloth; 21 x 13 in.; pp. (text) 157, 24 plates, frontispiece, and many halftones and drawings in text.

The final report of the engineers of the Delaware River bridge is rendered in the shape of a volume of most unusual interest and value in bridge history, and having as a disadvantage only its unmanageable form. Profusely illustrated with both photographic views and drawings, the volume gives a historical treatment of the development and evolution of the project for the Philadelphia-Camden bridge, and here recites in admirable, judicious manner the principal engineering considerations governing the development of the design. It then reviews the construction operations and their chief incidents, including detailed description of the cable spinning. The erection of the suspended structure is similarly treated, outlining the deformations which were experienced and which had to be overcome before the trusses could be joined. Appendices quite as valuable as the main report are attached, one of them being a monograph on the deflection theory as applied to suspension bridges with suspended trusses, by L. S. Moisseiff, an extended mathematical development, while others are an analysis of the top chord without top laterals, by A. Dana, abstract from the specifications, and full reports of the test and special inspection work. It will be recalled that the Delaware River bridge was particularly notable for the extent and informative character of its special test work. The future of suspension bridge construction will always be indebted to this enterprise for the information here brought out.

An Epitome of Sewage-Works Design

SEWAGE WORKS—By E. C. Temple, M.Ins.C.E., F.R.San.I., Chief Town Engineer, Jamshedpur, Chief Engineer, Tata Iron and Steel Co., Ltd., Jamshedpur. London (England): Crosby, Lockwood and Son (Stationers' Hall Court, Ludgate Hill, E.C.4). Cloth; 6x9 in.; pp. 67; 29 line cuts. 5s., net.

In considering the merits of this notable little book, this statement by the author should be kept in mind: The book is designed primarily for the "average man" with "a fair knowledge of civil engineering" to enable him "to design and construct a sewage disposal installation which will work"; its "rules will apply particularly to India and the tropics, but will be found reasonably applicable elsewhere." With these limitations in mind, the book deserves high praise as a remarkably concise and clear exposition of sewage treatment, as applied to population groups from 2,000 down to a family of 5. Many of the principles set forth are applicable to larger works, but the illustrations—all line cuts, filling about a third of the 66 pp.—come within the range stated. After his introductory pages, the author takes up screens, grit catchers, essentials of sewage treatment, "simple" septic tanks and filters. He then considers four kinds of tanks —macerating (placed between septic tanks and filters), sludge digestion, storm overflow, and two-story. The final chapters are on the activated-sludge process and "how to use analyses."

For the "average" engineer in the Far East and many other parts of the world who lacks the more extended books on sewage treatment, or needs in addition a simpler exposition of sewage treatment, dealing with small plants, Mr. Temple's book will be worth many times its small cost. It is worth adding to the library of any engineer who is or may suddenly be called on to deal with sewage treatment.

By a Construction Superintendent

STANDARD CONSTRUCTION METHODS—By G. Underwood, Construction Engineer. New York and London: McGraw-Hill Book Co., Inc. Leather; 6x9 in.; pp. 407; 330 line cuts and halftones. $5.

Here is a book written by a field superintendent of construction for other practical workers of his kind. In general the author sticks to his purpose and herein lies the book's value. In the places where he reaches away from his defined task of keeping strictly to the superintendent's functions, the book fails to be good. In all, however, the poor parts are few. The treatment generally is in detail, the reader is not told in a general way how to perform the task described, but is led through the sequence of operations step by step.

Practical construction men have developed various ways of doing things; therefore, frequently in studying this book they will find that the author's methods are not theirs. They are, however, methods which he has tested in practice and they will work, so the tyro in construction may have confidence in them and the experienced builder has at least the benefit of comparison.

A striking chapter is that on erection and rigging, capability in which an old construction man once told the reviewer was his criterion of the technical ability of a field superintendent. This chapter has sections on tackle, tackle blocks, wire rope tackle, gin poles, erection of smoke stacks, shears, pole derricks, derricks, winches, chain hoists, and jacks. There are 67 pp. and 81 illustrations, most of them diagram sketches of knots, lashings, hitches, slings, derrick and gin-pole erection, tackle arrangements, anchorages and erection processes. The text is equally full and wherever practicable is condensed by tabulation. The other chapters are: organization and equipment, excavation, piledriving, concrete construction, wood construction, steel construction, roofing and flashing, lathing and plastering, scaffolds, pipework, painting and construction schedule.

Hydraulic and Other Nomograms

NOMOGRAMS for Hydraulic and Other Calculations Occurring in Irrigation Work—Prepared for the Panjab Irrigation Department. Cloth; 14x9 in.; numerous diagrams and 27 pp. of explanatory text, with tabular values. $4, from P. Brindley, superintending engineer, Panjab Irrigating Department, Almanzar, Simla E., India.

Those who find the use of nomograms advantageous in their computations will be interested in the 58 diagrams of this type presented in this well-made volume, all but 7 of which were "designed by the authors," while the 7 were drawn to "standard form," with slight alterations "with a view to greater convenience and wider util-

ity." The nomograms fall in five groups: Channels, weirs, orifices, materials and general, the latter being "beginners' plates." For channels, the nomograms deal, among other things, with the Kutter, Bazin and Chezy and various exponential formulas; also with Kutter's *n*, discharges, various channel elements and percolation losses. Under orifices, there is a nomogram for standing waves and sewer discharges.

Efficient Road Building Methods

MANAGEMENT AND METHODS IN CONCRETE HIGHWAY CONSTRUCTION—By J. L. Harrison, Highway Engineer, U. S. Bureau of Public Roads. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 242; 74 halftones and line cuts. $3.

Road builders generally will need no introduction to the author of this volume or to the records and analyses which it contains. As highway engineer in the Bureau of Public Roads, the author carried on for months, with a considerable staff, a series of efficiency studies of road building operations. At the end of this study he put his conclusions into a group of notable articles published by the bureau journal, *Public Roads*. It is this same investigation carried further upon which the present book is based. The conclusions presented are not personal opinions but findings from scores of time studies and performance counts.

Altogether, the book is a notable contribution to the growing literature on highway engineering and construction. This may hardly be denied by those constructors, and they are many, who will not go with the author the full distance of his claims of the possibilities of better construction management. The book has the merit that it is succinct—the little over 200 pp. of text and tables cover: Planning and conduct of work; production management; purchasing aggregate for yield; preparing the subgrade; fine grading and form setting; handling aggregate and cement; the proper truck supply; hauling to mixer by truck; field stockpiling; industrial railway hauling to mixer; final fine grading; mixer operation; water in mixing and curing; origin and cost of over-runs, and organization and equipment.

For Engineers and Surveyors

FIELD ASTRONOMY FOR ENGINEERS AND SURVEYORS—By David Clark, M.A., B.Sc., M.Inst.C.E., M.Inst.C.E.I., Assoc. M.Am.Soc.C.E., Professor of Civil Engineering, University of Dublin. London: Constable & Co., Ltd. Cloth; 5x8 in.; pp. 164; 50 halftones and line cuts. $3.50 from D. Van Nostrand Co., New York.

Accurate geodetic control of surveys for cities large and small sooner or later must come. And as the need for such precise surveys becomes more generally urgent one casts about for concise handbooks on methods of procedure. The older, though then sufficient, link-and-degree surveying practice is being outlawed by reason of increasing property values and a greater appreciation of the necessity of first-off accurate control.

While Mr. Clark's volume does not yield as accurate and delimited data as one will find in certain publications of the U. S. Geodetic Survey, it is a happy combination of information that will serve both the layman and the technician adequately. The book is in three parts: Principles, instruments and observations. The major considerations are gone into fully, so that the book will serve both field men and students of astronomy and geodesy. Of particular interest is the discussion of methods of longitude determination with the aid of wireless telegraphy.

A History of Flying

THE CONQUEST OF THE AIR: An Historical Survey—By C. L. M. Brown, M.A. New York: Oxford University Press, American Branch. Cloth; 5x8 in.; pp. 126; 8 halftones. $1.

The author states that the aim of his book is to tell the story of man's conquest of the air in its historical setting. This he does well enough, starting in what he terms "the pre-scientific period" and carrying the story always in an interesting manner, but to a somewhat disappointing ending in 1912. It is disappointing because the modern history of flying during and since the World War, which has such a vital interest today, is not considered. But withal it is an interesting volume suitable for the general reader and a worthy addition to the publisher's series of "World Manuals" which treat, among other subjects, politics, economics, art and the history of science.

Engineering Drawing

DRAFTING FOR ENGINEERS: A Textbook of Engineering Drawing for Colleges and Technical Schools—By Carl Lars Svensen, M.E., Professor of Engineering Drawing, Texas Technological College, M. A.S.M.E., M. S.P.E.E.; Formerly Professor of Engineering Drawing, Ohio State University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 363; 583 line drawings and halftones. $2.75.

In his preface the author well states the purpose of engineering drafting as the development of "the ability to think in the graphic language." His book expands his premise by an unusual stress of visualization both of shape and of size. In fact, a theory of dimensioning as originally developed by the author is given in a separate chapter. Besides the usual information found in textbooks of engineering drafting, somewhat of an innovation is introduced by devoting separate chapters to specialization on architectural, structural and electrical drafting.

British Municipalities and Their Work

THE MUNICIPAL YEAR BOOK FOR 1927—C. F. Bulpitt, Editor. London: The Municipal Journal. Cloth; 6x9 in.; pp. 900. 15s.

As in previous issues, this year book combines a directory of British municipal activities and officials with a large amount of general information on national governmental departments having to do with municipal affairs; on the statutory powers of the various classes of municipalities; and on progress in garbage and refuse collection and disposal, sewage treatment, municipal housing and other municipal fields. Many tabular data are given on such subjects as water, gas and electric supply, street railways, municipal baths, markets, libraries, tax rates and mayors' salaries. Only liberal advertising patronage makes it possible to present year by year so much information as The Municipal Year Book contains.

A Descriptive Geometry Text

DESCRIPTIVE GEOMETRY—By C. H. Schumann, Jr., C. E., Assistant Professor of Drawing, Columbia University. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. 249; 164 line cuts. $2.50.

This work is the result of the author's experience in teaching descriptive geometry at Columbia University. It is presented as nearly as possible from the students' viewpoint and the problems have been arranged to follow the development of their minds in the subject. Each chapter is a series of illustrative problems developed in turn by an analysis, a construction, and a check. Review problems are inserted at the end of each chapter. Starting with points, lines and planes, problems on single

and double curved surfaces, warped surfaces, surfaces of revolution and surface intersections are subsequently considered in order to carry out the logical concept of descriptive geometry as the basis and theory of mechanical drafting.

Revised and Condensed

ESTIMATING BUILDING COSTS—By Frank E. Barnes, C. E., M. Am.Soc.C.E., M.A.A.E., Building Valuation Engineer of the New York Central Lines. Second Edition (first edition published under the title of "Estimating Building Costs and Appraising Buildings"). New York and London: McGraw-Hill Book Co., Inc. Flexible; 5x7 in.; pp. 592; many halftones and line cuts, tables and charts. $5.

Estimators familiar with the first edition of this book will find the revised volume has some 225 fewer pages due to ellisions of certain tables of commodity prices, to condensation by tabulation and to omissions of matter easily found elsewhere. The most important revision is in the building labor tables. In the light of changed efficiency of labor, these have all been recast to give the amount of labor required at the present time to perform the various kinds of work described. All building materials prices have also been revised. The chapter on concrete and that on structural steel have been largely rewritten. The book still remains the vast compilation of building cost and price data which made the original edition noteworthy.

Publications Received

RAILWAY FREIGHT TRAFFIC in the Chicago terminal district is the subject of a 175-p. cloth-bound report issued by the General Managers' Association of Chicago (J. W. Higgins, chairman, 608 So. Dearborn St., Chicago). It describes in detail the facilities and traffic movements in this complicated terminal system, which comprises 7,726 miles of track, 255 freighthouses and 578 freight yards for 37 trunk and local railroads in an area of 1,750 sq. miles.

TORNADOES is the subject of several interesting articles in "Monthly Weather Review" of April. There are statistical reviews of tornadoes in Virginia and in Arkansas for periods of 111 and 46 years respectively. Specific descriptions are given in separate articles of the Illinois tornado of April, 1927, and the tornadoes of April 12 at Rock Springs, Texas, and Fort Smith, Ark. The Fort Smith tornado was observed at a distance of less than a mile from the Weather Bureau Office, but was a relatively weak tornado, according to the effects reported. (15c. from U. S. Weather Bureau, Washington, D. C.)

A SPECIAL JOINT REPORT on Stream Pollution in Wisconsin, covering studies made from July 1, 1915, to Dec. 31, 1926, by the Conservation Commission and the State Board of Health, takes up pea cannery wastes, pulp and paper mill wastes, including experiments on both; investigations of industrial wastes at Ripon and of both sewage and industrial wastes at Waupun; general and chemical studies of the pollution of the Fox, Wisconsin, Flambeau and Sheboygan Rivers; and a survey of the Mississippi in relation to pollution from Minneapolis, St. Paul and smaller places. The report, which extends to 328 pp., was prepared by the Bureau of Sanitary Engineering (C. M. Baker, chief) of the Wisconsin State Board of Health, Madison, Wis.

A TENTATIVE PLAN for the publication of papers on sewage-works operation and sewage research is outlined in the *Proceedings* of the New Jersey Sewage Works Association for 1927. Papers on design would not be accepted. The publication would bear the notation "Published by Allied Sewage Publications," or some other name to be adopted later. The *Proceedings* also contains various papers before the association, including the report of the association's sewage research committee and a discussion—virtually an extension of the report—by Dr. Willem Rudolfs, chief, New Jersey Sewage Experiment Station, New Brunswick. The secretary of the association is John R. Downes, supervising engineer, Plainfield joint sewage-works, Bound Brook, N. J.

THE THIRD MONOGRAPH in the Engineering Series of the Regional Plan of New York and Its Environs ($2; address, 130 E. 22nd St., New York City) is a valuable study of Land with a main title, Land Values, and a subtitle, "Distribution Within New York Region and Relation to Various Factors in Urban Growth." The authors are Harold M. Lewis, executive engineer of the Committee on Regional Plan, Wayne D. Heydecker and Raymond O'Hara. There is a Foreword of ten pages by Thomas Adams, director. Tables, diagrams and maps, some colored, are included. The range of the study is indicated by the factors affecting land values that are discussed. These are transit and transportation, high buildings, street widenings and extensions, large-scale public improvements, wide streets, land subdivision, public open spaces, speculation, interest and tax rates and the index of commodity prices. The regional area here considered embraces 5,528 sq. miles, with average land values ranging from $57 an acre for Putnam County to $4,500 for New York City and $460,000 for Manhattan Borough.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ELECTRIC ELEVATORS: Their Design, Construction, Operation and Maintenance—By F. A. Annett, Assistant Editor, *Power*, M. A.I.E.E., Author of "Electrical Machinery." New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. 447; 351 line cuts and halftones, 3 insert plates. $5.

THE ELEMENTS OF MINING SCIENCE—By David E. Thomas, B.Sc., M.I.Min.E., Organizer of Mining Instruction under the Warwickshire Council. New York: Oxford University Press, American Branch. Board, cloth back; 6x10 in.; pp. 80; 5 line cuts. $1.50.

"These notes" were originally prepared for a "course of lectures to teachers" of science in a mining district of England. The book considers mine air, methane, spontaneous combustion of coal, air conditions and colliery explosions.

FEDERAL RECLAMATION LAWS ANNOTATED: A Chronological Compilation of the Public Statutes of the United States Relating to the Federal Irrigation of Arid Lands; With Notes of Decisions of the Courts, the Comptroller, the Comptroller General, the Attorney General, the Department of the Interior and the Bureau of Reclamation—March, 1927, Edition of 1920 Revised and Enlarged by Glenna F. Sinclair under the Direction of P. W. Dent, Assistant to the Commissioner, Bureau of Reclamation. [Deparment of the Interior, Hubert Work, Secretary; Bureau of Reclamation, Elwood Mead, Commissioner.] Washington, D. C.: Government Printing Office. Cloth; 6x9 in.; pp. 385.

The contents of the book were briefly noted in our issue of July 28, 1927, p. 136.

GRAPHIC THERMODYNAMICS—By W. S. Huntington. New York: D. C. Heath & Co. Cloth; 6x8 in.; pp. 205; 67 line drawings. $2.80.

Deals "particularly" with the varied problems relating to the compression and expansion of air, gases and vapors. The author believes "the graphical method to be new." His aim has been "to place in the hands of engineers and engineering students 'a useful book—the heat-work diagram'."

HOW TO INFLUENCE MEN: The Use of Psychology in Business—By Edgar James Swift, Head of the Department of Psychology in Washington University, St. Louis, Author of "Psychology and the Day's Work." [A New and Enlarged Edision of BUSINESS POWER THROUGH PSYCHOLOGY.] New York: Charles Scribner's Sons. Cloth; 6x9 in.; pp. 407. $3.

Dedicated to "The many salesmen and sales managers whose conventions the author has addressed and whose enthusiasm and interest awaken pleasant memories."

THE MATHEMATICS OF ENGINEERING—By Ralph E. Root, Ph.D., Professor of Mathematics and Mechanics, Post Graduate School, United States Naval Academy. Baltimore, Md.: The Williams and Wilkins Co. Cloth; 6x9 in.; pp. 540; 115 line drawings. $7.50.

NEUZEITLICHE FREITRAGENDE DACHEINDECKUNGEN: Versuche, Theorie und Praktische Anwendungen zum Behelf für Ingenieure, Architekten, Baubehörden und Baugeschäfte—Von Dr.-Ing. Luz David, Magistratsbaurat in Berlin. Berlin: Julius Springer. Paper or cloth; 6x9 in.; pp. 68; 73 halftones and line cuts. Paper, 6 m.; cloth, 7.2 m., in Germany.

SAFETY RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRICAL SUPPLY AND COMMUNICATION LINES: Comprising Part 2 of the Fourth Edition, National Electrical Safety Code. [Handbook Series of the Bureau of Standards (Department of Commerce, Bureau of Standards, George K. Burgess, Director), No. 10.] Paper; 5x8 in.; pp. 322; 16 charts, 92 tables. 60c. from Superintendent of Documents, Washington, D. C.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Fort Churchill Chosen Terminus of Hudson Bay Ry.

The Dominion Government has definitely decided upon Fort Churchill as the terminal of the Hudson Bay Ry., following the recommendation of Frederick Palmer, the British expert, who was engaged to investigate the respective advantages of that port and Port Nelson. Such a decision was reached because practically unlimited shipping accommodation can be provided and at a minimum of cost; borings recently taken over an extensive area show easily dredged material and no rock within 50 ft. of the low water level; it is superior to Nelson in safety, cost of construction and economy of time; and it is accessible for 30-ft. vessels at all stages of the tide.

The railway will not likely go to Nelson now but will branch off at the present end of steel and proceed to Churchill. This will involve the construction of some 70 additional miles of railway at a cost of $5,000,000, but the economies effected on the harbor improvements and aids to navigation will more than compensate for this outlay. The cost of laying steel to the bay, providing adequate terminal facilities, and grain elevator at Churchill and establishing the necessary aid to navigation in the Straits it is estimated will not exceed $20,000,000. Something like $22,000,000 has already been expended on the project.

Standardization Is Topic for Highway Officials Conference

Standardization of construction and design in the building of roads will be one of the principal subjects of discussion at the annual meeting of the American Association of State Highway officials which will be held in Denver Oct. 3 to Oct. 6. In addition, an effort will be made to secure agreement on a uniform system of accounting. Uniformity also will be sought in provisions for traffic control and in safety work. Standing committees of the association will bring in definite recommendations, summing up studies which have extended over several years.

Plans will be laid at the Denver meeting for the presentation to Congress of the views of the states with regard to the amount of money the government should continue to appropriate for federal-aid roads. All of the federal aid thus far authorized will have been absorbed by June 30, 1928. The question of the amount to be authorized for the succeeding two fiscal years will come before the next Congress. The states absorbed $80,000,000 during the fiscal year ended June 30.

Johnson's Enlarged Wanaque Plan Adopted

Recommendations of Snow Accepted —Johnson Comments on Dismissal and Continues Work

THE enlarged size Johnson plan for duplicate "smooth-bore" steel pressure pipe lines, endorsed in the report by F. Herbert Snow, briefly summarized on p. 230 of *Engineering News-Record* last week and dealt with more fully on pp. 251 and 274 of this issue, was approved by the North Jersey District Water Supply Commission on Aug. 11. The plan endorsed by Mr. Snow includes two 74-in. pipe lines instead of two 72-in. for the upper portion of the aqueduct, two 72-in. instead of two 60-in. for the intermediate section and two 72-in. lines instead of one for the lower portion.

No announcement was made as to who will have engineering charge of the work but as the action of the previous week rescinded the substitution on the aqueduct work of Col. George A. Johnson for Arthur H. Pratt and Morris R. Sherrerd, chief and consulting engineer respectively, the natural assumption is that they will be expected to carry out the new plan. There has been speculation as to their willingness to do this in view of their strenuous opposition to the new plan.

Johnson's Statements

Colonel Johnson, in an "interview" in the Newark *Evening News* of Aug. 10, takes exception to his dismissal, asserts (through "friends") that he has a contract for the engineering work of designing and building the aqueduct, and intimates that he will continue preparing plans and specifications for it—which he says are near completion.

The issue of the Newark *News* already mentioned thus summarizes the action of the commission in dismissing Colonel Johnson's and the reasons for the dismissal advanced at the time:

The resolution dismissing Mr. Johnson was passed unanimously by the Commission at the instance of Mayor Raymond, one of its members. The Mayor gave as one reason for his action the fact that employment of Mr. Johnson at his terms of a commission fee basis would involve a cost of $200,000 or $300,000. This cost, the Mayor added, would be unwarranted in view of the fact that the commission has an engineering staff which involves a sizable pay roll.

Another reason given by Mr. Raymond was that Mr. Johnson was represented to him as having given conflicting opinions as to the carrying capacity of the 72-in. twin steel pipes he recommended. The mayor obtained his information from John S. Ely, water engineer for the city, who interviewed Mr. Johnson subsequent to the filing of the latter's original report March 29.

Mr. Johnson's statement in the Newark *News* follows nearly in full:

Respecting the announcement in the Newark *Evening News* of Aug. 5, wherein Mayor Raymond is reported as having offered a resolution at the commission's meeting relieving me of further responsibility as engineer in connection with the water transportation lines between Wanaque dam and Belleville reservoir, until I ascertain the facts and misleading statements which must have been supplied to Mayor Raymond to inspire his reported public announcement, and his reported action dictating my removal from the active field in the Wanaque aqueduct controversy, any statement of mine necessarily must be incomplete.

I know of no sufficient reason why Mayor Raymond offered this resolution, nor why it was unanimously voted by the commission. The newspaper account states that Mayor Raymond's action was taken because, having once reported on this matter, and subsequently having been interviewed by Mr. Ely, water-works engineer for Newark, I gave Mr. Ely certain figures opposed to those contained in my report of March 29. There is a misconception somewhere in this important par-

Dr. A. C. Humphreys, Former Head of Stevens Institute, Dies

Dr. Alexander Crombie Humphreys, who retired last June as president of the Stevens Institute of Technology, Hoboken, N. J., after 25 years' service in that capacity, died at his home in Morristown, N. J., on Aug. 14.

Dr. Humphreys was a noted educator and a brilliant water-gas engineer. He had been an executive in fifty gas and electric companies in the U. S. including the United Gas Improvement Co. of Philadelphia. His interests were diversified and he was influential in public affairs. He was a leader in a movement for recognition of American painters and had owned a famous collection of work by American artists.

Dr. Humphreys was born in Edinburgh, Scotland, on March 30, 1851, and came to the U. S. in 1859. In 1881 he was graduated from Stevens Institute of Technology, acting as superintendent of a gas company in Bayonne, N. J., while he pursued his course of study. Later on, as his achievements grew, he was given degrees from the University of Pennsylvania, New York University, Columbia University, Brown University, Rutgers College and Rennsselaer Polytechnic Institute. He was a member and past-president of the A.S.M.E. and was a member of many other technical and industrial organizations.

ticular. I discussed the matter with Mr. Ely in my office, but I did not then, nor have I ever, essentially deviated from the position taken in my report of March 29.

I believed then, and still do, that twin steel 72-in. pressure lines will deliver all the water derivable from the Wanaque shed, and *all of the time* satisfy to the limit of the potentialities of the Wanaque watershed and those of the Wanaque dam, the agreements now in existence between the water commission and the various communities who will receive the benefit of this development.

Following the commission's resolution of May 5, whereby I was authorized to prepare plans and specifications for a 150-m.g.d. steel aqueduct and to supervise the construction of the same to its completion, my studies still continued for the benefit of the interested communities. I found that considerable money could be saved in future, and more competent service rendered to the contracting municipalities, by increasing the size of the steel lines between Wanaque dam and Little Falls to 74 in. in diameter.

Somewhat complicated hydraulic studies were encountered during the preparation of plans and specifications. The possibility of using Great Notch reservoir, to an extent not previously contemplated, indicated the advisability of substituting 74-in. tubes for the 72-in. initially recommended. This change will not materially increase the cost of the pipe lines, and involves advantages of such nature that the contracting municipalities will be able to secure, in an approved manner, a greater amount of water, and at less expense than that contracted for on the concrete grade aqueduct proposition. Saving in pumping charges and utilization of Great Notch reservoir, whereby gravity will be substituted for pumping, is herein involved. Mr. Snow's report is very enlightening in this regard.

I have read Mr. Snow's report to the commission, dated Aug. 3, and I am gratified to learn that in all essential particulars he agrees with my initial findings. He has, however, strengthened my conclusions by suggestions which must be given the greatest weight. His report speaks for itself, and I agree with him in his findings.

As per the resolution passed by the commission May 5, I shall shortly complete the design of the twin steel lines and the accompanying specifications. The contract for this work can be advertised at once, especially now, because of the fact that Mr. Snow has agreed that twin steel lines are the proper type of aqueduct to construct, and that my plan for the twin steel lines will *more than meet* all contract requirements, together with additional economic-engineering possibilities never before reported.

From some source, unknown to me, Mayor Raymond apparently has received inaccurate representations, or else those sketchily informing him of any minor changes have exaggerated to him their ideas in the intimate premises. To my mind this must be so, because those continuously and inexplicably opposed to the steel adqeduct indubitably have poisoned the minds of some of the contracting municipalities' officers and of the representatives of the state in whom rests the responsibility for this great expenditure of money and the fruition of the initial step in the management by the state of New Jersey of its water supply policies.

I stand by my original recommendations, and shall always do so. Of course, work of this magnitude must of necessity be subject to minor, and perhaps in extraordinary cases, major changes as it goes forward. I have no explanation other than this to make at this time respecting the somewhat peculiar situation now existing, but which I am certain will iron itself out in a very short time.

Engineering Fifty Years Ago

From *Engineering News*, August 18, 1877

CINCINNATI is taking the lead of American cities in the introduction of the electric light. It has an "Electric and Calcium Light Company," and this company has ordered a "gramme" machine from Paris. The electricity for the gramme machine is generated by steam power. The cost of putting the machine in operation will be between $1,500 and $2,000. It is of three-horsepower, and its expenses after the first cost will be simply for operating, including the attendance for one man. The result of the experiment will be watched with interest.

Chicago to Study Design of School Buildings

A committee of engineers, architects and contractors has been appointed by the Citizens Public Education Commission, of Chicago, to investigate the building construction program and building designs of the public schools. This action results from charges that have been made involving structural defects and skimping on contract work. Chester L. Post, structural and industrial engineer, is chairman of the committee, and the other ten members include mechanical and electrical engineers and contractors so that both the construction and equipment of the buildings will be considered.

International Testing Materials Congress to Convene Sept. 12

The International Congress for Testing Materials at Amsterdam, Sept. 12-17, 1927, which is considered a first manifestation after the war of international co-operation on the subject of testing materials, promises to have the interest of the experts of many nations.

In the general meetings of the congress the following will read papers: T. D. Lynch, East Pittsburgh, Pa.; A. Mesnager, Paris; Prof. Korber, Düsseldorf; and Dr. Rosenhain, England.

The subjects to be treated at the congress are divided in three sections: (A) Metals; (B) cement, concrete, stone and brick, and (C) miscellaneous, (oils, rubber, wood, etc.). In each section twenty-seven papers will be presented. The papers will be read in English, French or German. Because of the limited time, the speeches will not be translated during the sessions.

The meetings of the congress will be held at the University of Amsterdam. During the congress an exhibition of materials of the Dutch colonies will be held at the Royal Colonial Institute at Amsterdam.

Congress proceedings, containing the complete papers and a summary of the discussion will appear after the congress in two illustrated volumes. The price of those two volumes will be 20 guilders for participants. Orders may be addressed to the congress office.

The congress fee is fixed at 10 guilders for participants.

Information may be obtained by writing to the office of the International Congress for Testing Materials, Valckenierstraat 2, Amsterdam.

Inland Waterways Starts Upper Mississippi Service

The United States Inland Waterways Corporation on Aug. 15 inaugurated its Upper Mississippi Division running between St. Louis, Missouri, and St. Paul and Minneapolis, Minnesota. The first trip was made by one towboat and three barges loaded with sugar and general merchandise leaving St. Louis, Missouri, for the Northwest. Three barges loaded with grain are at the Twin Cities ready to be brought down the river on the return trip.

Every five days trips will start at both ends of the line, stops being made at intermediate points. An average of twelve days is required for a round trip. The barges are of 3,000, 2,000, and 500-ton capacity. The entire fleet consists of 275 towboats, barges, and miscellaneous boats with a cargo capacity of 1,750,000 tons per annum.

First Steps Taken in Building Detroit-Windsor Tunnel

Preliminary arrangements have been completed and the first actual steps taken in connection with the construction of a proposed vehicular tunnel under the Detroit River connecting Windsor, Ontario, with Detroit, Mich. Test borings have been made on the Canadian side, and soundings in the river along the proposed route of the tunnel. It is proposed to tunnel the approaches and sink the tunnel lining of the river section in a dredged cut across the bottom of the Detroit River.

The Windsor Council passed a by-law on Aug. 5 authorizing the Detroit and Windsor Subway Co., sponsors of the project, to construct approaches to the tunnel under certain named down-town Windsor streets. Corporation Counsel Charles P. O'Neil, of Detroit is to be conferred with at an early date relative to drafting an ordinance authorizing construction work by the company in connection with the Detroit approaches. Provisions in the ordinance insisted upon by Mayor Smith of Detroit have been agreed to by the tunnel company.

F. G. Engholm, Toronto engineer, is the original promoter of the tunnel project, the financial backing of which it is claimed by the sponsors has been assured.

ASHEVILLE CITY HALL OF MODERN DESIGN

A NEW court house and a new city hall will form the nucleus of group planning at Asheville, N. C. The city hall is now being built. Work on the county building was also started this spring. The courthouse will be 14 stories in height, on an area adjacent to that occupied by the municipal building. Both structures will face Pack Square, the central point of the city. An arcade 80 ft. in length will connect the two edifices.

Designed by Milburn, Heister & Co., Washington architects, the courthouse will have a base 130 ft.

square. The construction will be of steel. The lower portion will be faced with North Carolina granite and the upper portion with Bedford sandstone. The plans call for marble columns from the seventh to the tenth floors, inclusive. An ornamental tile roof will top the structure. All window casings will be of metal.

The courthouse will accommodate all county courts and offices, together with allied agencies of government. The county jail will be included, with hospital.

Work is promised completion during 1927.

Arthur Kill Bridges Progressing Rapidly

Due to rapid construction progress, completion of the two cantilever highway bridges across Arthur Kill at New York City may be expected half a year earlier than originally contemplated—by the summer of 1928 instead of early in 1929—according to a report just issued by the Port of New York Authority. The Tottenville-Perth Amboy bridge, with a main span of 750 ft. and a total length of 10,140 ft. between ends of approaches, has its substructure work 85 per cent complete (72 of 79 piers are nearly completed); of the 17,000 tons of superstructure steel two-thirds has been fabricated and a large part of the plate-girder approach work is already erected. The substructure is being built by P. J. Carlin Construction Co. and Frederick Snare Corporation, under contracts aggregating $3,296,000, while the superstructure is being built by McClintic-Marshall Co. for $2,599,150. Work began in July, 1926.

Contracts for the Elizabeth-Howland Hook Bridge were let at the same time, and similar progress has been achieved. This structure has a 672-ft. cantilever span and is 8,575 ft. long over approaches. The substructure is 95 per cent completed and 70 per cent of the steel superstructure has been fabricated. These contracts are in the hands of Triest Contracting Corporation and Frederick Snare Corporation for the substructure, at a total of $2,297,370, and Bethlehem Steel Co. for the superstructure steelwork, at $1,888,269.

O. H. Ammann is bridge engineer of the Port Authority; Weddell & Hardesty, consulting engineers, are in charge of the design, and William J. Boucher is engineer of construction.

Army Hearing on 57th St. Bridge Over Hudson Set for Sept. 9

The War Department, having under consideration the application of the North River Bridge Co., Room 738, Pennsylvania Station, New York City, for approval of plans for a bridge to be constructed across the Hudson River at 57th St., Manhattan, New York City, a public hearing to consider the matter will be held before a board of officers appointed for that purpose, in the Army Building, 39 Whitehall St., New York City, at 10:00 a.m. (Daylight Saving Time), Sept. 9, 1927.

The plans submitted by the applicant show a suspension bridge with minimum vertical clearances above mean high water at center, of 175 ft. for a width of 500 ft., and 166 ft. for a width of 1,500 ft., and an unobstructed channel between the established pierhead lines.

Heyman & Goodman Awarded Subway Work in Philadelphia

Contract for building the next section of the Broad St. subway in Philadelphia has been awarded to Heyman & Goodman of New York City, builder of several sections of the 8th Avenue subway in New York. The contract amounts to $7,269,880, and is for constructing the section from City Hall to Kater St. Heyman & Goodman's bid was $173,750 less than the bid of the Keystone State corporation.

Indian Railways Plan 5,000-Mile Program

The construction of 1,000 miles of railway annually for a term of five years is the program announced to the British government by its secretary-of-state for India. That country has now 38,000 miles of line, of which 27,500 miles are owned by the government, 15,000 miles being operated directly and the remainder by companies.

Random Lines

A Tip to Bridge Designers

The following description, W. S. reports, is taken verbatim from "Ready Reference Diary, 1927," published in Springfield, Mass.:

"The Bear Mountain Hudson River Bridge was opened in November, 1924, and is the longest in the world, 2,252 ft. It was carved almost entirely out of solid rock, and contains 12,552 tons of steel . . ."

* * *

"Highest Dam" Question Settled

Heavy snows have halted the construction operations on the Milton Bowman dam at Emigrant gap in Nevada County, Cal., about 100 miles east of Sacramento near the state boundary line, according to V. Sandbothe, who has been in charge of hospitalization at the camp. The concrete wall, which extends across the lower end of a valley, will be 900 ft. in height. At its base the wall will be 150 ft. thick. The dam has been built up some 400 ft. already.—Portland *Oregonian*.

* * *

What a Baseball Manager Thinks About

I think the major league should appoint a man, preferably an engineer and if possible a former ballplayer, to make regular inspection of all the diamonds in the different parks and see that the pitching mounds are exactly the same, both as to elevation and distance. I venture to say that right now no two of them are the same.—N. Y. *Evening Journal*.

* * *

A New Job for the City Engineer

The following marriage licenses were issued Tuesday from the city engineer's office. Homer Elliot Gardner to Miss Jessie Conaway, and Newton Ernest Aldrich to Miss Betty Ratcliff Foreshaw, all of Montgomery.—Montgomery (Ala.) *Advertiser*.

* * *

What Makes It Run?

From the Chicago *Tribune*.

A. H. Blanchard Resigns Highway Engineering Post at Michigan

Arthur H. Blanchard who has been professor of highway engineering and highway transport at the University of Michigan for several years and who has been on leave of absence during the past year on account of ill health, has resigned from the university and will hereafter devote his time to consulting work with offices at Toledo, Ohio. Roger L. Morrison who has been director of the Michigan State Highway laboratory and Professor Blanchard's associate in the highway engineering and transport work at the university will take charge of the university work and assume Mr. Blanchard's duties.

All of the work of the department of civil engineering in various lines of transportation will be much more closely co-ordinated. The offices of Prof. John S. Worley who returns as professor of transportation and of Walter C. Sadler, assistant professor of railway engineering, will be moved to rooms adjoining those occupied by the highway engineering department. The transportation library of the university will be moved into the quarters formerly occupied by the Davis Library and the Davis Library will be maintained in its present form as a separate unit but in and adjoining room and both libraries will be administered together.

Walter J. Emmons, highway research specialist at the U. S. Bureau of Public Roads, Washington, D. C., has been appointed associate professor of highway engineering and director of the state highway laboratory.

Rapid Progress Made on Power Project at Paugan Falls

Construction work is progressing rapidly on the Paugan Falls power development of the Gatineau Power Co., on the Gatineau River, in the province of Quebec. This is the largest of three power plants being built by the company on the same river. The plant is designed for eight units of 34,000 hp. each. The power will be generated at 6,600 volts and stepped up to 220,000 volts for transmission.

The following quantities of excavation, concrete and reinforcing have been completed: Earth excavation, 17,341 cu.yd.; rock excavation, 242,955 cu.yd.; concrete in the powerhouse substructure, 5,162 cu.yd.; reinforcing steel in the main dam, spillway and bypass, 353 tons; reinforcing steel in the powerhouse and penstocks, 72 tons.

Large Fresh-water Harbor for Vancouver Proposed

Vancouver will have one of the greatest fresh-water ports in the world, in addition to all its present waterfront facilities, if tentative plans which have been prepared by Major W. G. Swan for submission to the Board of Harbor Commissioners are put into effect. These plans are for the construction of a dam at the Second Narrows, just east of the bridge and upon completion would replace that structure. The estimated cost is $5,500,000. The dam, when it is constructed, will be sufficiently wide for a broad street, railway and street car tracks, and water mains for the supply of the city and adjacent municipalities.

Two locks would penetrate the dam, one large enough for any ship afloat and a smaller one for lesser craft. Bascule bridges over each lock, or one swing span over both would be provided. The water-mains would dip below the locks. A spillway more than 100 ft. wide would care for the surplus inflow from fresh-water streams above the dam, which would feed the inner harbor.

Personal Notes

R. T. McKay has opened an office in Room 317 Fidelity Building, Benton Harbor, Mich., for practice in structural engineering.

H. B. Smith has completed his work as resident engineer on paving and sewer improvements in Melbourne and Titusville, Fla., and is now on vacation in Canton, Ohio.

Karl O. H. Nielsen, a member of the harbor commission of Sweden, recently spent a week inspecting the New York Barge Canal, starting from Syracuse, N. Y., and surveying terminals and locks and canal harbors.

Clarence M. Keckler, recently graduated from Pennsylvania State College, is now engaged in sanitary engineering with the Monmouth Consolidated Water Co. as chemist and bacteriologist in charge of water rteatment. His address is Red Bank, N. J.

E. E. Harper, consulting engineer, Kansas City, Mo., announces that he has opened an office at 4010 Penn Ave., Kansas City, and a shop for the manufacture of dry feed equipment and other devices constructed under his own patents for feeding chemicals in water purification and softening plants. The business will be handled by the Omega Machine Co. of which he is president, the business relating to municipal water supplies, water purification, power plants, and appraisals, examinations and reports.

John W. Kelsey, superintendent and engineer of the St. Paul water-works, has been appointed chief engineer of the department of public works, St. Paul, vice George M. Shepard, resigned. Mr. Kelsey's position on the water board will be filled by a civil service examination.

George P. Hawley, who has been resident engineer at the Cedar Rapids plant of the Montreal Light, Heat & Power, Consolidated, has been appointed resident engineer for the newly-organized Montreal Island Power Co., which will have charge of the development of power on the Back River, north of Montreal.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Meeting, Boston, Mass., Sept. 13-16, 1927.

AMERICAN WELDING SOCIETY, New York City; Fall Meeting, Detroit, Mich., Sept. 19-23, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Columbus, Ohio, Oct. 12-14, 1927.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Dallas, Texas, Nov. 14-18, 1927.

ASPHALT PAVING CONFERENCE: Under the auspices of the Asphalt Association and Association of Asphalt Paving Technologists; annual conference Atlanta, Ga., Nov. 28-Dec. 2, 1927.

The Western Society of Engineers on Aug. 17, visited the newly completed deep-water harbor at Buffington, Ind. (described in *Engineering News-Record*, July 21), and, as guest of the Universal Portland Cement Co., inspected its large cement plant at Buffington. On the boat trip to the plant moving pictures were shown of the new harbor, the special freighters, the huge harbor crane and operations ir the manufacture of cement.

The Indianapolis Scientech Club on Aug. 15 had an address on "Automatic Train Control" by O. E. Wright.

The Michigan Engineering Society has planned a meeting in Houghton, Mich., in the copper country in the Upper Peninsula, for Sept. 5 to 7, with a program mostly relating to copper production, and with inspection of the buildings of the Michigan College of Mines at Houghton. Information about the Houghton meeting and the ways to go can be had from E. L. Brandt, executive secretary, Michigan Engineering Society, 478 West Alexandrine Ave., Detroit.

Obituary

Francis T. Bowles, rear admiral, retired, formerly chief constructor of the U. S. Navy, died Aug. 3 on his estate at Barnstable, Mass., aged 68 years. Admiral Bowles was born in Springfield, Mass., graduated from the U. S. Naval Academy in 1879, served in the engineering department of the navy until 1881 and was then transferred to the construction department; he reached the grade of rear-admiral and chief constructor in 1901. He was a noted shipbuilding engineer and architect, was president of the Fore River shipyard, was interested in the development of the Cape Cod Canal, and during the World War was assistant general manager of the Emergency Fleet Corporation.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Hydraulics Booklet

The new publication of the Hydraulic Society described in these pages recently as "one of the most practical hydraulic texts so far as pumping requirements are concerned that is available" may be obtained from the offices of the society at 90 West St., New York City. Through an oversight, the address was not given in the original announcement. This correction is made because of the many requests that have been received for the address.

Business Notes

Mid-West Locomotive Works, Cincinnati, Ohio, announces the recent appointment of the following territorial representatives: James A. Ridgway, New York; H. E. McCoy Co., Pittsburgh; H. B. Owsley, operating as the Lakewood Equipment Co., St. Louis; and Clare Osborn, Ltd., Montreal, Quebec.

Wm. B. Scaife & Sons Co., Pittsburgh, manufacturer of steel tanks and water purifying apparatus, announces that J. R. Sproat has recently been appointed superintendent to succeed G. A. Meckel, whose death occurred several months ago.

Blaw-Knox Co., Pittsburgh announces it has purchased the Milliken Brothers Manufacturing Co., New York, manufacturers of transmission towers, radio towers and standard steel buildings. A considerable amount of the business of the Milliken company has been in the export field and the present Milliken organization will continue to function in this field and will take over the management of the export business of the Blaw-Knox Co. on all of its products. The manufacturing for both companies will be concentrated at the Blaw-Knox Co. plants at Pittsburgh and Baltimore.

J. B. Hamilton, for twenty years associated with the Wickes Machinery Co., Jersey City, has announced his retirement from that company as vice-president to become associated with the C. W. Pritchard Co., Inc., also in Jersey City. The Pritchard company is a machinery merchant, selling machine tools and construction equipment.

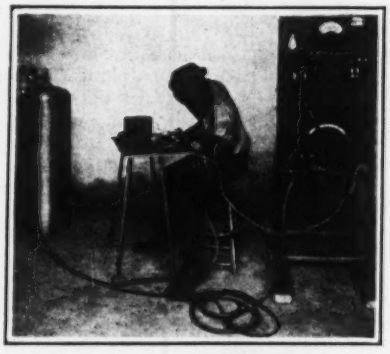
Long Leaf Yellow Pine Manufacturers' Association, New Orleans, La., has announced that Herbert F. Adey had been appointed eastern representative for the association with headquarters at New York. Mr. Adey has been connected with long leaf pine interests in the capacity of sales manager and other positions for many years.

Ernest B. Perry, president, Industrial Works, Bay City, Mich., died at his home Aug. 7, after an illness of one week. Mr. Perry went with the Industrial Works as chief engineer in 1889, after graduating as a mechanical engineer from the University of Michigan. He was a member of the American Society of Mechanical Engineers and affiliated with various other national organizations, in addition to being a director of the research department of the University of Michigan and prominently identified with that school's activities. Mr. Perry was 59 years old.

New Developments

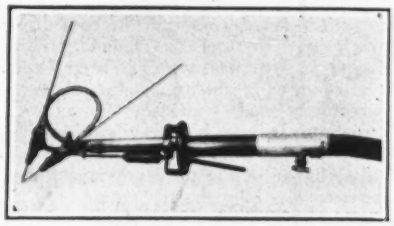
Equipment for Atomic Hydrogen Welding Developed

Atomic hydrogen welding, making possible the welding of many special alloys and the production of ductile welds in iron and steel, is now made practicable by the use of equipment placed on the market by the General Electric Co. This method utilizes the passage of a stream of hydrogen through the arc between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine



again a short distance beyond the arc into molecules of the gas, and in so doing liberate an enormous amount of heat. The experiments leading to the development of this process were described in *Engineering News-Record*.

The welding outfit consists of (1) a single-phase transformer for converting the voltage of a 60-cycle source of power to one suitable for the welding equipment; (2) a specially designed variable reactor to provide the proper welding current and voltage for different classes of work, and (3) the welding torch. The latter consists of a holder supporting two tungsten wire electrodes each supported inside a nozzle; the hydrogen gas is forced out around electrodes. In contrast to the usual method of electric arc

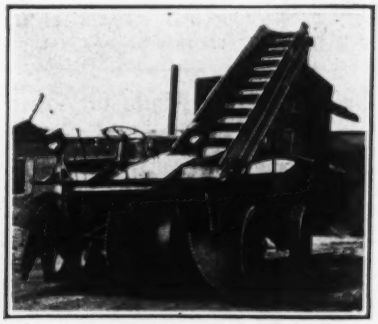


welding, there is no current flowing from the electrodes to the work to be welded. The circuit is completed from one electrode to the other.

At present the new equipment is being marketed for operation on 60-cycle single-phase circuits only, and is recommended for use on ordinary metals of less than ¼ in. in thickness or on hitherto unweldable metals of greater thickness.

Snow Loader Designed for Hard Service

Designed and built primarily for loading snow and ice, the machine shown in the illustration not only loads the



snow but grinds it up and condenses it about 50 per cent. The machine runs on its own power and is claimed to thoroughly clean snow under its worst packed condition. The escalator is 28 ft. long, 30 in. wide and 18 in. deep and travels at the rate of 170 ft. per minute. The front paddles are 30 in. in diameter and travel at the rate of 100 r.p.m. The width of swath is 72 in. The machine is mounted on a standard chassis of about 3½ tons capacity, propelled by a Buda six-cylinder engine developing about 90 hp. The snow loader is manufactured by the Fox Rotary Snow Broom Co., New York City.

New Machine Reclaims Brick

A machine for reclaiming ordinary building and paving brick is a new product of the Rotor Air Tool Co., 5905 Carnegie Ave., Cleveland, Ohio.

It is claimed that the machine will remove mortar and cement from the brick and assist in the general shaping up of worn brick.

As shown in the illustration, the machine consists of a table below which a main shaft running in Hyatt roller bearings carries two special cutting heads, which project upward slightly through two slots in the table. The table itself is adjustable in order to give the desired amount of contact for the brick being cleaned. The openings in the table are connected to an exhaust blower for removing the material to a convenient place. A dust-proof motor, mounted on a hinged and counterbalanced motor base, which automatically provides belt tension, is the source of power.

It is claimed that with a crew of three men this machine will clean 3,000 9-in.

brick per 10-hr. day. This is said to compare with a maximum production of 900 9-in. brick for three men under the usual hand chipping methods. Tests are said to have shown that the actual cost of reclaiming is usually less than 1c. per brick, including interest on investment, cost of cutters, current consumption and direct labor cost.

Conveyor Designed for Brick Unloading Service

An especially designed belt conveyor for unloading brick from barges to trucks on the dock is a new product of the George Haiss Mfg. Co., Inc., New York City. The machine consists of a conveyor frame 40 ft. long mounted on swivel wheels on the dock end and on a 2-wheel truck with a fifth wheel swinging arrangement allowing laborers to move and steer it in the desired direction on the barge. The wheels mounted

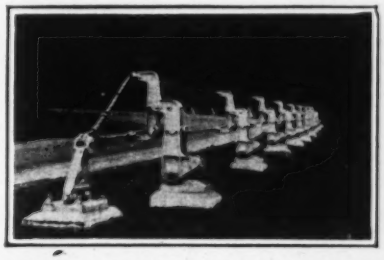
on the dock can be swiveled to run parallel with the water or can be turned at right angles for moving on and off the boat. The conveyor is also adjustable as to vertical angle.

The main feature of the machine is its use of a 20-in. wire belt running on ball-bearing rollers. These rollers are mounted on a spring-suspended box which allows them to release and thus not take the jar of the brick as they are thrown on the belt. In the company's experience this wire belt is the most satisfactory and suitable device for handling brick and similar material. The conveyor is driven either by electric motor or gasoline engine.

A Resilient Highway Guard

A new highway guard built on the principle that a resilient mechanical device be embodied within the cable supports to cushion and absorb the forces of impact and that the materials used shall be capable of withstanding heavy blows, has recently been patented by Joseph H. Ramsey, Albany, N. Y., and has been used in District No. 1 of the New York State department of highways.

The guard rail supports are of malleable iron and consist of bases upon which are pivotally mounted pairs of vertical struts or side plates on cupped bearings. These struts support at their upper ends equalizers pivotally mounted on cupped bearings between them. The equalizers are maintained in their normal positions by pairs of compression springs located between the vertical struts. The struts are wider apart at the bottom than the top to effect proper side-bracing

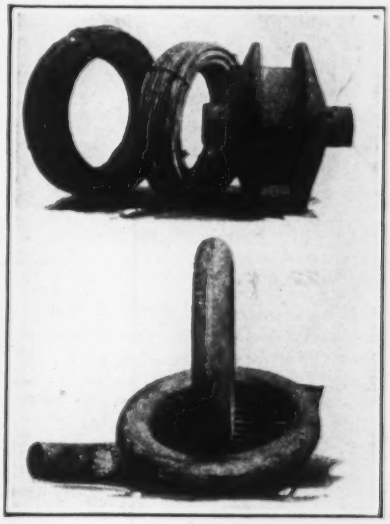


and are maintained in their normally vertical positions by heavy compression springs at the rear of the bases. Upon the facing portion of the equalizers are two brackets projecting toward the highway upon the ends of which the cables are freely suspended by U-shaped stirrups. The ends of the cables are passed around sheaves in malleable iron brackets which are hinged to base castings upon concrete foundations.

It is stated that "they may be installed on 16-ft. centers, thus keeping the cost per lineal foot of guard-railing very close to that of the older forms."

Wire-Wound Chain Ring

For the large rings of hoisting chains or slings, which are hung upon the hook of a crane or hoist, a forged coil or wire is being introduced as a substitute for the usual welded ring of bar iron. In the new ring, wire is coiled upon a spool to form a blank of the desired size. This blank is then heated and is compressed between dies under a powerful hammer or press, thus compacting the wires tightly. In the test of a ring 9½ in., in inside diameter and with a cross-sectional diameter of 2¼ in., the ring



straightened out and finally parted under a load of 230 tons. This type of ring has been adopted as standard in the shops of the Baldwin Locomotive Works, Philadelphia, and is described in the July number of *Baldwin Locomotives*, issued by this firm. A patent has been applied for.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL HARDWOOD LUMBER ASSOCIATION, Chicago; Annual Convention, Chicago, Sept. 15-16.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Semi-annual meeting, Aviation Country Club, Detroit, Sept. 19-21.

AMERICAN PAINT & VARNISH MANUFACTURERS ASSOCIATION, Philadelphia; Annual Convention, Atlantic City, Oct. 24-25.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, New York; Annual convention, Pinehurst, N. C., Oct. 25-29.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

New Publications

Pneumatic Concrete Placing — RANSOME CONCRETE MACHINERY CO., Dunellen, N. J., has published a 19-p. booklet covering in a complete and thorough

manner the pneumatic placing of concrete. It explains how compressed air handles concrete, describes the company's pneumatic type placers, gives information of distances to which concrete can be shot, on the required consistency of the concrete, on the size of the aggregates and on the size of the discharge line, besides including a number of illustrations of important jobs upon which the equipment has been used. The company's pneumatic grout mixer and placer is also briefly described.

CORRECTION

Welded Pipe Line—LINDE AIR PRODUCTS CO., New York City, has recently published a booklet entitled "Long Pipe Lines with Oxwelded Joints." An item describing this booklet in the July 28 issue of *Engineering News-Record* erroneously referred to these as arc welded joints.

Well Systems—LAYNE & BOWLER, INC., Memphis, Tenn., has published a very complete catalog on its well water systems and vertical turbine pumps. The catalog is made up of a number of sections treating such subjects as hydrology, Layne water-supply service, gravel wall well system, shutter screens, wire wrapped screens and a list of many users of Layne & Bowler equipment. Other sections illustrate the use of Layne well systems for the paper-making industry, municipalities, power plants, irrigation projects, packing plants, railroads, and refrigeration plants. Section 8 is devoted to vertical turbine pumps. It describes their use and illustrates the various types of pump heads available. Section 9 contains useful tables and engineering data.

Belt Conveyors — LINK-BELT CO., Chicago, has published a data book known as No. 615 on the use and adaptation of belt conveyors. It has been the desire of the company to make this handbook on belt conveyors as valuable in its field "as Carnegie is in its particular engineering field." It is also a catalog showing the progress that has been made in the art of conveying materials and many pictures of installations add to its usefulness. This book is similar to the company's typical elevator book No. 680 and its silent chain drive data book No. 125, all of which have been published so as to tabulate and arrange fundamental facts, figures and examples for the potential users of such equipment, so that they may do their own designing and selecting if they so choose. It is a valuable publication for all engineers interested in belt conveyor possibilities.

Secondary Road Surfacing — TEXAS CO., New York City, has published a new booklet entitled "Texaco Road Surfacing Materials" in which are described methods of maintaining earth, sand clay, gravel, macadam, shell, cinder and similar road surfaces with Texaco products varying from a light dust layer containing approximately 30 per cent asphalt to a product containing 86 per cent asphalt.

Business Side of Construction

Facts and Events That Affect Cost and Volume

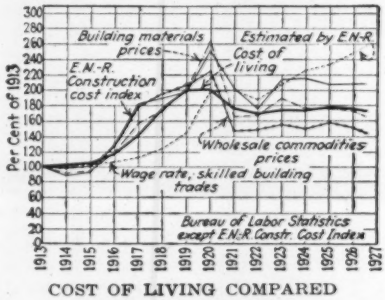
Labor Keeps Up Cost of Construction

Living Costs, Prices of Building Materials and Wholesale Commodities All Tend Downward

WITH a decidedly downward movement in current prices of building materials, wholesale commodities and cost of living in general, it is evident from figures indicated in the accompanying chart, that labor alone keeps construction costs at present high levels.

Construction cost (labor and materials) in a nation-wide sense, as shown by the *E. N.-R.* Construction Cost Index Number, averaged 208.03 for the whole of 1926, with 1913 equaling 100. The average for the first six months this year is 208.63, a very small fraction above the 1926 yearly level but nevertheless a rise.

Wages of skilled building trades mechanics, for the entire U. S., as computed by the Bureau of Labor Statistics, stood at an index number of 248 for May, 1926, taking 1913 as 100. The Bureau's figure for May of this year not being available, an estimate by *E. N.-R.* places it at approximately 258.


Per Cent of 1913
Building materials prices
Estimated by E.N.-R.
Cost of living
E.N.-R. Construction cost index
Wholesale commodities prices
Wage rate, skilled building trades
Bureau of Labor Statistics except E.N.-R. Constr. Cost Index

COST OF LIVING COMPARED WITH OTHER COSTS

Cost of living figures are computed semi-annually by the Labor Bureau, adopting 1913 as the base year. December, 1926, was 75.6 per cent with June, 1927, 73.4 per cent above the 1913 level.

The Government building materials index numbers, based on 1913 as 100, stood at 173.4 as an average for 1926, with the average for the first six months of this year, 166.6. The wholesale commodities number, average for 1926, is 151.1, with 145.1 representing the first half of 1927.

It costs the building trades mechanic less to live, on a retail price basis, than it did six months, or even eighteen months ago. Wholesale prices of goods sold to the retailer also declined at about the same angle, as shown in the diagram. Costs of materials handled by the building laborer in his daily work, declined more sharply than did those of general commodities, therefore, it is plainly the wage rate curve that serves as a buoy for construction cost.

Costs per KW. of Four Power Plants

Unit costs on four power plants in Colorado and New Mexico have been furnished by Wood & Weber, Inc., Denver, Colo., who constructed them. These kw. costs were as follows:

Fort Morgan, Colo. — Power plant, two 1,000 kw. units and two boilers. This is a 400-lb. pressure plant, up-to-date in every respect. Cost approximately $192,000 or *$96 per kw.*

Colorado Springs, Colo.—Steam plant, two 2,500-kw. turbines, with land, railway trackage, condensing water equipment, etc. Thoroughly modern, with 400 lb. pressure, and cost $518,000 or *$103 per kw.*

Alamo, Colo.—Plant at mine of Alamo Coal Co., consisting of one 125 kw. turbine, two 200 lb. pressure boilers, condensing equipment, spray pond, etc., including a heavy duty 600-hp. electric hoist, all completely equipped, and the hoist in a concrete and brick building. Cost, $115,000 or a little under *$100 per kw.*

Raton, New Mexico—Municipal plant for Raton Public Service Co., consisting of two 750 kw. turbines, two 300 lb. boilers, condensing equipment, spray pond, etc. Cost approximately $186,000 or *$124 per kw.*

Information Available on Seventeen Foreign Projects

The Department of Commerce has made a digest of world-wide construction reports received by its machinery division. Further information on the following seventeen foreign projects may be had by writing to the Department of Commerce, Machinery Division, Washington, D. C.:

New plans for grain elevator construction in Poland.
City of Iquique, Chile, authorized to contract public works loan.
Budget for port works in Spain.
Various public works under construction in Bilboa, Spain.
Notable construction activity in Trail, British Columbia.
New Howrah Bridge, India.
Rio Negro dam and power plant, Uruguay, planned for 1928.
Bank of Greece to finance building construction.
Tunnel construction in Japan.
Contract awarded for Halifax immigration shed.
Time extension allowed on railroad construction in Matto Grosso, Brazil.
German firm awarded railroad construction contracts in Turkey.
Tenders to be invited for building construction in Honolulu.
Proposed bridge construction in Burma.
New unit for auxiliary steam plant at Kimberley, British Columbia.
Considerable construction planned for Harbin, China, during 1927.
Funds for public works in Cali, Colombia.

Assorted Costs Culled From Construction News

IN ADDITION to the unit costs, materials prices and labor rates published weekly and, in greater detail, in the first issue of each month, the Construction News reports offer each week a broad field of special cost data. Following are a few of these data that were contained in construction reports published this year:

Concreting materials for Los Angeles brought the following low bids:

		Per Unit
Cement at mill	2,600,000 bbl.	$1.77 in bulk
Cement at mill	2,600,000 bbl.	2.22 in sacks
Cement delivered	2,600,000 bbl.	2.05 in bulk
Cement delivered	2,600,000 bbl.	2.50 in sacks
Sand on cars	1,620,000 tons	.50
Crushed stone on cars	1,330,000 tons	1.00

Pipe line in Texas, 150 mi. of 15-in. main, $12,000.

Vitrified clay sewer, laying, in Akron, Ohio, 8,125 ft. x 8 ft., let for $2.65 per lin. ft., engineer's estimate, $4.42.

Brick sewer in Columbus, Ohio, 2,075 ft. x 10 ft., let for $14.30 per lin ft.

Gasholder, Long Beach, Calif., 10,000 cu.ft., $619,000 or 6.10 cents per cu.ft.

Grain elevator equipment, Houston, Tex.: elevator extension, carrier house, installing machinery, $91,000 (engineer's est. $100,000); machinery, $59,698 (engineer's est. $50,000); 5,911 lin. ft. 42-in. rubber belting, $12,413 (engineer's est. $15,000.) Total, $163,111 (engineer's est. $165,000.)

Pipe line, Texas, 50 mi. 4-in., $275,000 or $5,500 per mi.

Stadiums awarded as follows:

Lawrence, Kan., $160,000.

Bayonne, N. J., concrete with steel covering, 8,000 capacity, 36 ft. high, 61 ft. deep, 570 ft. circumference, $217,000.

Ann Arbor, Mich., concrete, 70,000 capacity.

Jackson, Mich., 10,000 capacity, $90,000.

Birmingham, Ala., concrete, 40,000 capacity, $404,760.

Grand Forks, N. D., concrete and brick, 15,000 capacity, $134,270.

Muskegon, Mich., concrete, 354x62x31 ft. high, 6,263 capacity.

Grain elevators awarded as follows:

Kansas City, Mo., 1,000,000 bu., $500,000, $0.50 bu.

Kansas City, $250,000.

Clay Center, Kan., 120,000 bu., $50,000, $0.42 bu.

Kansas City, Mo., $1,000,000.

Enid, Okla., 500,000 bu., $100,000, $0.20 bu.

Wichita, Kan., 60x205x65 ft., $84,000, $0.11 cu.ft.

Owen Sound, Ont., 1,000,000 bu., $400,000 (est.), $0.40 bu.

Vancouver, B. C., $35,000.

Beech Grove, Ind., 800,000 bu., $120,000, $0.15 bu.

Carthage, Mo., 70 ft. high, $140,000.

Carthage, Mo., 32x52x93 ft., $40,000, $0.26 cu.ft.

Seattle, Wash., 500,000 bu., $150,900, $0.30 bu.

Sarnia, Ont., 1,000,000 bu., $507,000, $0.51 bu.

Vancouver, B. C., 42 bins, 90 ft. high x 20 ft. dia., $400,000.

Jersey City, N. J., 5-story, 40x50 ft., $150,000.

Swimming pools awarded as follows:

Cleveland, Ohio, 125x400 ft., concrete, steel covered, with locker house, $272,000 or $5.44 per sq.ft.

Montebello, Calif., two pools; 380,000 gal. and 45,000 gal.; $24,459 or 5.75 cents per gal. capacity. Filtration and sterilization equipment, $13,370 or 3.15 cents per gal. capacity.

Cleveland, Ohio, 120x240 ft., concrete, $138,700 or $4.82 per sq.ft.

South Bend, Ind., 100x165 ft., concrete, $135,000 or $8.12 per sq.ft.

Cisco, Tex., 267x700 ft., concrete, $60,000 or $3.21 per sq.ft.

Gunite concrete lining at Ventura, Calif., 30,000 sq.ft. 2 in. for 2,000-ft. ditch, at 12 cents per sq.ft. (January).

Asphalt plant, 3,000 tons, Philadelphia, Pa., $54,800 (February).

Gas pipe line, Texas-Missouri, 410 mi. 22 in., estimated $20,000,000 or $48,800 per mi.

Coal pocket, New Haven, Monn., concrete and steel, 65x100x150 ft. high, engineer's estimate, $125,000 or 14 cents per cu.ft.

Oil pipe line, Texas, 20 mi., 8 in., 12,000 bbl. daily capacity, $35,000 or $1,750 per mi.

Gas holders, Pomona, Calif., two, each 50,000 cu.ft., $110,000 or 11 cents per cu.ft. (May).

Gas holders, Erie, Pa., 185 ft. high x 210 ft. diameter, 5,000,000 cu.ft., water tank type, concrete and steel, $310,000 or 6.2 cents per cu.ft.

Fire hydrants for Elkhart, Ind., $59 to $78; average of ten bids, $67.

Labor rates per hour in Syracuse, N. Y., were estimated as follows by the three bidders on a paving job on which bids were opened June 23:

	(1)	(2)	(3)
Foreman	$0.60	$1.00	$1.00
Carpenter	.60	1.00	1.00
Mason	.60	1.00	1.00
Helper	60	.70	.70
Common	.60	.60	.70
Team	1.00	1.00	1.00
Light trucks	1.00	1.00	1.50
Heavy trucks	2.00	2.50	3.00

37.6 cents per cu.ft. is the total price on a school contract in Detroit, Mich., just awarded to the Stibbard Construction Co., Detroit. The building will be reinforced concrete, brick and steel, fireproof. If footings exceed 18 ft. the unit costs will be: excavation, $5.50; reinforced concrete, $10. If footings are less than 18 ft., excavation, $4; concrete, $10. Contract price for plumbing and heating, $34,630, or 21 per cent of grand total. Electrical contract, $5,067, or 3 per cent of total. The general contract price is $116,000 (footings 18 ft. deep). There are 415,575 cu.ft. and the total contract price is $163,151.65.

Paving materials contracts for New Jersey State Highway Department were placed at the following prices:

227,261 gal. asphalt oil	$0.08[0]3
62,290 gal. liquid binder	12
23,850 gal. joint filler	.113
26,500 gal. asphalt cement emulsion	.205
21,550 gal. patching	.138
2,870 tons bituminous concrete	10.801
97 tons sheet asphalt	25 300
52,185 gal. class B tar	.595
37,715 gal. class U tar	.167
26,370 tons stone	1.375

Coming Soon

Unit Costs for a Club House

Engineering News-Record **has obtained from an Ohio architect the unit prices covering the construction of a clubhouse worth $500,000. These prices are given under five general heads: (1) Ground contract; (2) plumbing, heating and ventilating; (3) electrical work; (4) miscellaneous; (5) extras. The 57 items are given in money and in per cent of total cost.**

Seven Months' Comparison of 1927 Contracts with 1926

THE figures following speak for themselves in that they show this year (Jan. 1 to Aug. 1) to have developed as heavy a volume of engineering construction as the corresponding period of the record year 1926.

This is true sectionally as well as by classes of work. Minimun contract value for each classification is explained on p. 288 under the caption, This Week's Contracts—With Comparisons.

The cumulative total, entire U. S., Jan. 1 to Aug. 1, 1927 is $1,755,629,000, against $1,659,106,000 for the same months last year.

MARKED SIMILARITY BETWEEN THIS YEAR AND LAST SHOWN BOTH BY CLASSES AND BY SECTIONS

	—Per Cent of Total— Value, U. S., Seven Months 1927	1926
Water-works	1.9	2.1
Sewers	3.6	3.5
Bridges	4.1	2.6
Excavation, etc.	1.8	0.9
Streets and roads	16.0	17.2
Buildings, industrial	8.7	11.8
Buildings, commercial	51.0	51.0
Federal government	1.6	1.8
Unclassified	11.3	9.1
Eng. construction	100.0	100.0

	—Per Cent of Total— Value, U. S., Seven Months 1927	1926
New England	8.1	8.3
Mid-Atlantic	30.9	31.1
South	7.6	11.0
Mid-West	24.1	24.4
West Mississippi	17.2	15.
Far West	12.1	10.1
United States	100.0	100.0

This Week's Contracts—With Comparisons

Minimum costs observed are: $15,000 for water-works and excavation, drainage, irrigation, levee, river and harbor projects; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, institutional, religious and other buildings.

Week ended	Public Work	Private Work	Total Contracts
August 18, 1927	$29,536,000	$25,441,000	$54,977,000
August 11, 1927	33,602,000	52,530,000	86,132,000
August 19, 1926	34,682,000	34,671,000	69,353,000
Jan. 1 to date			
1927	756,576,000	1,140,162,000	1,896,738,000
1926	724,090,000	1,136,299,000	1,860,389,000

E.N.-R. Index Numbers On August 1, 1927

COST	VOLUME
205.50	252

The Index Numbers are published in detail and with charts in the first issue of each month. The Cost Index is given in full from 1903 through 1926, with a thorough explanation of its method of computation, and a graphic comparison with many other index numbers, in the 48-page pamphlet entitled Engineering News-Record Construction Costs.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, per 100 lb	$3.34	$3.80	+$4.10	$3.10	$3.35	$3.87½	$3.10	$3.00	$4.00
Structural rivets, per 100 lb	5.00	3.80	4.75	3.50	3.75	4.64	5.00	5.25	5.50
Reinforcing bars, per 100 lb	3.24	2.80	2.75	—2.15@2.50	2.87½	3.77½	2.95	3.00	3.57
Steel pipe, black, 2½ to 6 in., lap weld, discount from list	48%	54%	54%	51%	48%	41%	.42@53.8%	48%	.....
Cast-iron pipe, 6 in. and over, per net ton	44.60	40.00	54.00	42.20	46.50	56.50	43.00	55.00	41.00
Concreting Material									
Cement, without bags, per bbl.	2.35†	2.40	2.05	2.05	2.22	2.85	2.51	2.65	—1.42
Gravel, ¾ in., per cu.yd.	1.75	2.20*	2.38	2.00	1.65	1.90	1.80	1.25	1.90*
Sand, per cu.yd.	1.00	1.40*	2.00	2.00	1.25	1.00	1.40	1.25	1.35*
Crushed stone, ¾ in., per cu.yd.	1.85	2.50*	2.83	2.00	1.75	2.50	1.70	3.00	2.00*
Miscellaneous									
Fir, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	.....	.....	.....	39.00	39.25	34.25	27.00	24.50	55.00
Pine, 3x12 to 12x12, 20 ft. and under, per M.ft. b.m.	62.00†	34.00	56.00†	.....	.....	.....	.....	.....	.....
Lime, finishing, hydrated, ton	18.20	24.50	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00‡	1.35	1.82	1.50	1.70	2.70‡	1.70	2.80‡	10.00*
Common brick, per M	17.00†	12.50	13.60	12.00	13.75†	8@12	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0724	.103	.....	.072	..085	.....	.10	.10
Hollow partition tile, 4x12x12, per block	.1027	.0724	.103	.076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+.86¼	.91½	1.10	.83½	.93	+ 1.04	.92	.98	1.03
Common Labor									
Common labor, union, per hour	.90⅝	.30	.....	.90	.....	.....	.60	.70	.....
Common labor, non-union, hour.	.....	.25	30@.50	.82½	.45@.60	.31¼@.50	.50	.62½	.30@.35

*Ton. †Delivered. ‡280-lb. net. +Advance. —Decline.

DEMAND for construction materials keeps substantially ahead of 1926, if comparison of cumulative contract totals, Jan. 1 to date, this year and last, furnishes an indicator of actual volume. Figures given in the table at the top of this page are for the entire country at minimum mentioned in each class.

The increased expenditure of money, concurrent with a decrease in total cost of 1.3 per cent, compared with a year ago, shows real gain. Labor rates (average for the U. S.) continue to seek higher levels in the building trades, despite reports of unemployment in several of the large centers.

It is estimated by the Car Service Division of the American Railway Association that 8.4 per cent more freight cars will be needed to haul sand, gravel and stone requirements for the current quarter, than were employed during the corresponding period last year. The increased need of lumber cars is placed at 1.2 per cent. Iron and steel, however, will use approximately 5 per cent and castings and machinery, 1.8 per cent fewer cars than in the period, July 1 to Oct. 1, 1926. Freight loadings, all classes taken together, Jan. 1 to July 30, 1927, were ahead of the corresponding period of any previous year on record, according to the Association's report.

THIS limited price list is published Weekly except in the first issue of each month and gives current prices on the principal construction materials in the chief cities. Valuable suggestions on costs of work can be had by noting actual biddings as reported in the Construction News and Unit Prices sections following.

The first issue of each month carries complete quotations for all of the basic materials and for the rest of the important cities, also wage rates for the principal building trades and common labor. The last complete list will be found in the issue of Aug. 4, the next on Sept. 1. Explanation of prices contained in the table will appear from time to time in this section; last shown Aug. 11, 1927, p. 247.

Orders to be filled, on books of the United States Steel Corporation, July 31, 1927, were approximately 14 per cent below those at hand on the same date last year. Production of bessemer and openhearth steel ingots has been reduced in about the same proportion as unfilled orders, compared with a year ago. The principal hot-rolled steel products hold firmly to the $1.80 per 100 lb. level, base, Pittsburgh.

Movements of both cement and brick are in greater volume than at this time last year. Cement mill stocks and stocks of burned brick at yards throughout the country, are sufficiently heavy to offset the present high rate of output and shipments and also to prevent advance in prices for some time to come.

Recent slump in shipments and orders of both hard and softwood lumber has not served to prevent a seasonal acceleration in production at mills. The increased output, though slight, will tend, if anything, to weaken prices.